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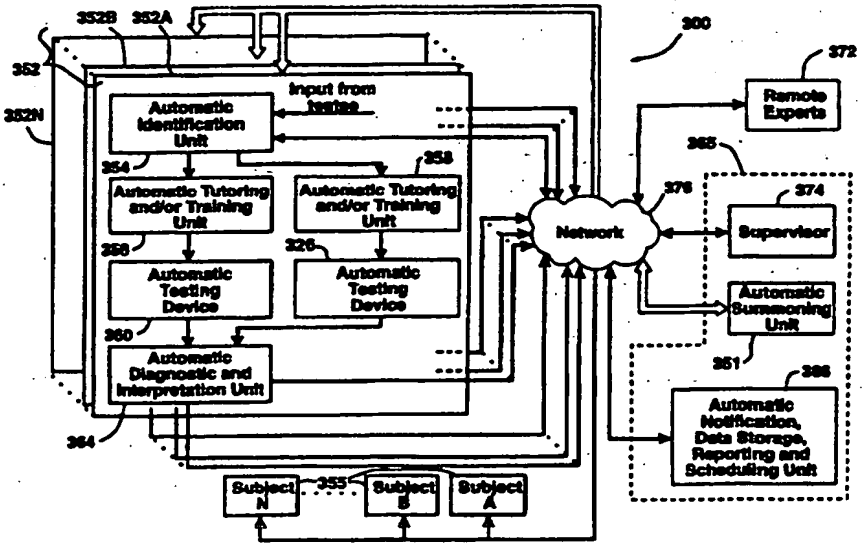
(57) Abstract

A system for automatically managing summoning to a session including at least one of self-testing and self-tutoring at least one subject which includes a summoning apparatus for summoning at least one subject to said session, apparatus for performing said session and a control apparatus for controlling said summoning and said session. A system and a method for automatic self-testing of vision. The system includes an optical testing unit for testing vision of a user and a computer connected to said optical testing unit. The computer controls the optical testing unit, receives data from the optical testing unit and processes and stores the test results. The system includes input devices for receiving user input and devices for providing automatic tutoring and training to the user. The system may also include devices for identifying the user. The system may also include devices for providing a report of the test results and for communicating the report to another local or remote computer. The method includes providing the user with self-tutoring and self-training for performing the self-testing, aut matically administering at least one vision test to the user, and storing the results of the test in a database. The method may also include identifying the user prior to testing, and providing a report of the test results. The optical testing unit presents at least one eye of the user with visual test images including a single test pattern and a multiple-choice answer pattern, receives answers selected by the user and analyzes the answers to determine the test result. The visual test images may be randomly or pseudo-randomly selected from a predetermined group of images for preventing the user from predicting the answers.



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A SYSTEM AND METHOD FOR AUTOMATIC MANAGEMENT OF SUMMONING, IDENTIFYING, SELF-TESTING AND/OR SELF-TUTORING OF SUBJECTS

FIELD OF THE INVENTION

The present invention relates to a system which automatically manages summoning, identifying, training, testing and tutoring of subjects in general and in particular to a system and method for automatically managing summoning, identifying , self-training, self-testing and/or self-tutoring and analysis of the results thereof of subjects in a predefined environment, such as a company.

BACKGROUND OF THE INVENTION

In many organizations, personnel are required to take tests, such as hearing and visual acuity tests, in order to meet certain regulations. Also, these personnel are required to be tutored for safety regulations (e.g. fire regulations) or quality control regulations imposed by quality control standards, such as the ISO standard.

These assignments typically require enormous human resources in order to manage the summoning, testing, tutoring, analysis of the tests results and resummoning of the personnel in accordance with the specific regulations.

One way to reduce the human resources required for these assignments is to conduct testing in which the person taking the test is self tested without additional human attendance. Such self testing systems are known in the art. However, the saving in human resources resulting from self testing is not significant enough.

For example, when performing vision tests, a testing apparatus is us d which is operated by an operator who identifies the tested person, explains how to use the apparatus, administers the test, and records the test results. This procedure is time consuming, requires highly trained operators and is therefore expensive.

For example, US Patent 4,740,072 to Griffin et al discloses a vision testing apparatus which is operated by an operator for administering a vari ty of visual performance tests to a test subject. The operator of the vision testing apparatus disclosed by Griffin et al. has to manually operate various buttons

and levers on the testing apparatus and to present a series of test slides to the test subject. Th operator also has to ask the t st subject various questions and to manually record the answers either on an appropriate form or alternatively initiate storage of the test results on a computer connected to the vision testing apparatus. Thus, even with computerized data storage of the test results, a qualified, trained operator must perform a substantiall amount of manual operations and must verbally instruct the test subject, which is time consuming and expensive.

SUMMARY OF THE PRESENT INVENTION

According to one aspect, the present invention provides an automatic system for managing summoning, identification, training, testing and/or tutoring assignments of personnel in an organization.

According to a further aspect of the invention, the training, testing and tutoring are self-training self-testing and/or self-tutoring.

According to yet another aspect of the present invention, the organization is a work place and the subjects are employees of the company which have to go through periodic qualification procedures. In a workplace, employees may be tested for their visual acuity and for their acquaintance with safety regulations and may be tutored so as to be familiar with standards qualification, such as the ISO 9000 qualification. The organization, however, may be any suitable organization, such as schools, universities, armed forces, police squads and the like.

In any such organization , the system of the present invention thus provides better management of health, safety, qualification and education of the subjects forming the organization.

The terms test, testing or examination refer throughout the specification and claims of the present invention to any test, such as a medical test, a qualification test, or a familiarity with regulations (e.g. safety regulations, standards) test taken by a subject employing the system of the preset invention.

The terms tutor or tutoring refer throughout the specification and claims of the present invention to a session wherein a subject undergoes any sort of tutoring, teaching and/or education session, such as a tutoring session to familiarize the subject with regulations such as safety regulations or standards. Tutoring sessions may or may not end in a test.

The term training refers throughout th specification and claims of the

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present invention to a session wherein a subject undergoes any sort of training in performing any type of self testing or self examination procedure such as training in performing a vision acuity self test or a hearing self test or any other self test.

The system of the present invention provides testing functionalities, tutoring functionalities and training functionalities or any combination thereof.

Thus, while the present invention is described in a preferred embodiment with respect of the testing functionalities, it is equally applicable to the training and tutoring functionalities.

According to one embodiment, the system for automatically summoning a subject to a session includes at least one self-testing, and/or self training/tutoring apparatus, at least one summoning apparatus for summoning at least one subject to that session, apparatus for performing that session and a control apparatus for controlling the summoning and the self testing and/or self tutoring session.

The system may also include identification means for identifying each subject before the session and means for analyzing the results of the session.

In one embodiment, the control apparatus includes a processor and a data storage unit connected to the processor for storing identification data of subjects. The data may also include the results of previous sessions and the control apparatus may also include means for comparing the results of previous sessions with results of a current session.

In a preferred embodiment, the summoning and the control apparatus are connected via a Local Area Network or a Wide Area Network. Thus, the summoning apparatus may include an electronic mail server for transmitting e-mail messages for the purpose of summoning subjects, a telephone for transmitting telephone messages for summoning subjects, an electronic mail billboard visible in a prime location in the organization, or a pager for summoning subjects. Alternatively or in addition, a summoning apparatus which does not require a network may be used, such as a printer for printing summoning messages for distribution to subjects. In the case of Wide Area Network, the INTERNET may be used as well.

The identification means may be any combination of an electromagnetic card reader, a voice recognition device, a video camera operative in conjunction with a pattern recognition software, a finger print analyzer, an iris analyzer, and a key-pad for keying a password. Preferably, identification means are operative throughout the session to verify the identity of the subject during the session.

The apparatus for performing the session preferably includes a subj ct

interface and means for performing self-testing and/or self-tutoring, a non-limiting example being self testing for conducting a medical test, as well as, means for performing a tutorial for qualifying subjects in accordance with qualification regulations.

In another embodiment, the system is also operative to automatically analyze the results of the self-testing and\or self tutoring. In one embodiment, the means for analyzing the results are remote from the apparatus which conducts the session. For example, the means for analyzing may include means allowing experts to receive the results and to input data related thereto.

In one embodiment, the apparatus for performing the session is remot from the summoning apparatus and control apparatus, whereby the subjects perform the session in a remote location. Preferably, the control apparatus is operative to determine the time of the next session and to indicate same to the summoning apparatus.

In yet another embodiment, the system may also include a human supervisor interface for allowing the supervisor to change parameters in the control apparatus.

In still another embodiment the self-training means include means for training the subject to perform a test.

Another object of the present invention to provide a system for automatic vision testing for enabling a subject to perform a session of visual self-testing. An aspect of the automatic vision testing system of the present invention, is th automatic provision of the subject with a session of self-training for self-testing himself.

Another aspect of the automatic vision screening system of the present invention is the provision of identifying means for identifying the subject which is being tested. A further aspect of the automatic vision screening system of th present invention is the provision of the subject with randomly or pseudo-randomly presented visual test images for preventing attempts of biasing the test results by the subject. Each of the visual test images includes a single test pattern and a multiple choice answer pattern. The subject selects one answer from the multiple choice answer pattern. In contrast with prior art vision tests, the subject is not presented with multiple test patterns in a single test image. Therefore there is no possibility to memorize the sequence of tests in advance and the test results cannot be thus biased by the subject

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Furthermore, another aspect of the automatic vision screening system of the present invention is the provision of means for detecting the presence of a subject when the subject is ready for self testing and for verifying the continuing presence of the same subject while the test is being performed for detecting an attempt by a person other than the identified subject to take the test instead of the identified subject.

Still further, another aspect of the automatic vision screening system of the present invention is the provision of means for changing the line of sight for enabling a subject to be self tested, while the subject is wearing bifocal, multifocal or progressive focus eye glasses, when switching from a test under far field conditions to a test under near field conditions.

There is therefore also provided, in accordance with a preferred embodiment of the present invention a system for automatic self-testing of vision. The system includes an optical testing unit for testing vision of a user and a computer connected to the optical testing unit for controlling the optical testing unit, receiving data from the optical testing unit and for processing the data. The computer includes means for receiving input from the user and means for providing automatic tutoring and training to the user.

Further, in accordance with another preferred embodiment of the present invention, the system includes means for identifying the user. The means for identifying may be selected from the group consisting of an electromagnetic card reader, a voice recognition device, a video camera, a finger print analyzer, an iris analyzer, a retinal pattern analyzer, a face analyzer , a keyboard or keypad for keying a password, a pointing device for selecting an item from a list and any combination thereof.

Further, in accordance with another preferred embodiment of the present invention, the means for receiving input from the user is selected from the group consisting of a keyboard, a pointing device, a touch sensitive screen, a light-pen, a microphone connected to a sound card, or any combination thereof and the means for providing automatic tutoring and training to the user is selected from the group consisting of a visual display unit, a loudspeaker connected to a sound card or any combination thereof.

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Further, in accordance with y t another preferred embodiment of the present inv ntion, th optical testing unit includes a light occluding housing, a test image projection unit attached to the housing for projecting a test image onto at l ast on eye of the user, an optical assembly, attached to the housing, for providing a viewing station from which the test image is viewed by the user and a controller unit connected to the test image projection unit, the viewing means and the computer, for controlling the operation of the test image projection unit and the optical assembly, and for bidirectionally communicating with the computer. The test image projection unit includes a test pattern projection unit for projecting a single test pattern the the user and an answer pattern projection unit for projecting a multiple-choice answer pattern onto at least one eye of the user.

Furthermore, in accordance with another preferred embodiment of the present invention, the test pattern projection unit includes a projector housing having an opening therein, the projector housing is movable along a direction orthogonal to the viewing axis of the user the projector housing, and includes a plurality of slide assemblies, and a slide illuminating unit positioned within the slide rotating assembly for illuminating a selected one of the plurality of slide assemblies positioned in front of the opening. Each of the slide assemblies includes at least two pairs of test slides and each of the pairs of test slides can be viewed by the user by moving the projector housing of the test pattern projection unit to a predetermined position.

Further, in accordance with another preferred embodiment of the pres nt invention, the answer pattern projection unit includes a slide holder for holding an answer pattern slide, an illumination unit for illuminating the answer pattern slide and a reflector for projecting an image of the answer pattern slide onto at least one eye of the user.

Further, in accordance with another preferred embodiment of the present invention, the optical assembly includes means for adjusting the test imag for testing far field vision, near field vision and intermediate field vision and m ans for deflecting the line of sight for adapting the optical device for use by a user wearing bifocal, multifocal or progressive focus eye glasses.

Further, in accordance with yet another preferred embodiment of the present invention, the optical testing unit further includes an ye enclosure

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having a plurality of light sources arranged horizontally within the eye enclosure for testing the horizontal field of view (FOV) of the user. The eye enclosure may include a sensor for sensing the presenc of the head of the user within the eye enclosure.

Further, in accordance with yet another preferred embodiment of the present invention, The sensor includes an emitter attached to a first side of the eye enclosure for emitting a beam of radiation and a detector attached to a second side of the eye enclosure for detecting the beam of radiation. The beam of radiation may be selected from the group consisting of a visible light beam, an infra -red light beam and an acoustic radiation beam.

Further, in accordance with another preferred embodiment of the present invention, the optical testing unit further includes at least one glare illumination unit for providing illumination for visual testing under glare conditions. The glare unit can be rotated so as to minimize the reflection of stray light within the optical testing unit.

Further, in accordance with another preferred embodiment of the present invention, the line of sight deflecting means include a movable prism for deflecting the line of sight and a motor for inserting the prism into the optical axis of the optical assembly and for removing the prism from the optical axis of the optical assembly.

Further, in accordance with another preferred embodiment of the pres nt invention, the line of sight deflecting means include a pair of the pair of non-parallel mirrors into the optical axis of the optical assembly and for removing the pair of non-parallel mirrors from the optical axis of the optical assembly.

Furthermore, in accordance with another preferred embodiment of the present invention, the means for deflecting the line of sight include a movable head-rest pivotally attached to the housing for enabling a user wearing bifocal, multifocal or progressive focus eye glasses to change his line of site.

Further, in accordance with another preferred embodiment of the present invention, the system includes storing means for storing the test result data.

Further, in accordance with y t another preferred embodiment of the present invention, the optical testing unit includes a light occluding housing, means for projecting a test image onto at least on eye of the user and means for providing a viewing station from which the test imag is view d by th user.

Further, in accordance with another preferred embodiment of the present invention, the single test image includes a single test pattern and an answer pattern.

Further, in accordance with yet another preferred embodiment of the present invention, the answer pattern is a multiple choice answer pattern.

Furthermore, in accordance with another preferred embodiment of the present invention, the means for projecting a test image is a display unit.

Furthermore, in accordance with another preferred embodiment of the present invention the display unitcan be selected from the group consisting of a cathode ray tube (CRT) display, an electro-luminescent display, a plasma display and a liquid crystal display (LCD) device coupled to a light source.

There is also provided, in accordance with another preferred embodiment of the present invention, a system for automatic self-testing of vision by a user. The system includes means for providing the user with automatic tutoring and training in the performing of the self testing, means for automatically administering at least one vision test to the user and for storing the results of the vision test. The system may also include means for identifying the user.

There is also provided, in accordance with another preferred embodiment of the present invention, a method for automatic self-testing of vision by a system for automatic self testing of vision, the system comprising an optical testing unit and a computer connected to the optical testing unit for controlling the optical testing unit, receiving data from the optical testing unit and for processing the data. The computer includes means for receiving input from th user and means for providing automatic tutoring and training to the user, the method includes the steps of providing the user with self-tutoring and self-training for performing the self-testing and automatically administering at least one vision test to the user.

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The method may further include the step of storing the results of the visual tests in a database. The method may further include the step of identifying the user prior to p rforming the steps of providing, automatically administering. The method may further include the step of providing a report including the results of the vision tests. The report may be selected from the group consisting of a hard-copy report, a report displayed on a display, a report communicated from the computer to another local or remote computer through a communication link, a report stored on suitable removable storage media and any combination thereof.

Furthermore, in accordance with another preferred embodiment of the present invention, the visual tests may be selected from the group consisting of a vision acuity test, a lateral and vertical phoria test, a stereoscopic depth perception test, a visual fusion test, a horizontal field of view (FOV) test, a color vision test and a vision acuity under glare conditions test. The vision acuity test and the vision acuity under glare conditions test can be selectably administ red to the right eye, the left eye or to both eyes.

Further, in accordance with another preferred embodiment of the present invention, the step of automatically administering includes the steps of presenting at least one eye of the user with visual test images, each of th visual test images includes a single test pattern and a multiple-choice answer pattern, receiving answers selected by the user through the means for receiving input during the visual test and analyzing the answers to determine the test result of the visual test.

Furthermore, in accordance with another preferred embodiment of th present invention, the visual images are randomly or pseudo-randomly selected from a predetermined group of visual images for preventing prediction of th visual images by the user.

Furthermore, in accordance with another preferred embodiment of the present invention, the number and type of the test images presented to the user is determined by the test history of the user for reducing the test duration.

There is also provided, in accordance with another preferred embodiment of the present invention, a system for automatic self-testing of vision. The system includes an optical testing unit for testing vision of a user, the optical

t sting unit being capable of proj cting a test image onto at least one eye of the us r, the test image is selected out of a plurality of test images, the test image includes a test pattern and a multiple-choice answer pattern and a computer connected to the the optical testing unit for controlling the optical testing unit, receiving data from the optical testing unit and input from the user and for processing and storing the data and the input . The computer includes means for receiving the input from the user and means for providing automatic tutoring and training to the user. The order of presentation of the test images may be randomized or pseudo-randomized by the system. The system may further further include means for identifying the user.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be understood and appreciated more fully from the following detailed description taken in conjunction with the drawings in which:

Fig. 1 is a schematic illustration of a self testing and/or tutoring syst m, including medical testing devices and safety regulation testing functionality, constructed and operative in accordance with a preferred embodiment of the invention;

Fig. 2 is a schematic block diagram illustrating a preferred method of operation of the systems of Fig. 1;

Fig. 3 is a schematic illustration of a self-testing, self-training and/or self-tutoring system, including a plurality of testing units for performing medical testing, training and/or tutoring, constructed and operative in accordance with another preferred embodiment of the invention;

Fig. 4A is a schematic block diagram illustrating a system for automatic self testing of vision, in accordance with a preferred embodiment of the present invention;

Fig. 4B is a schematic block diagram illustrating a system for automatic self testing of vision connected to a central or host computer, in accordance with another preferred embodiment of the present invention;

Fig. 4C is a schematic block diagram illustrating a system for automatic self testing of vision connected to a local area network (LAN), in accordance with still another preferred embodiment of the pres nt invention;

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Fig. 4D is a schematic block diagram illustrating a system for automatic self testing of vision connected to a wide area network (WAN) and to a telemedicine center through the public switched telephone network (PSTN), in accordance with yet another preferred embodiment of the present invention;

Fig. 5 is a schematic isometric view illustrating the system for automatic self testing of vision of Fig. 1;

Fig. 6 is a schematic isometric view illustrating of the eye enclosure of the system for automatic vision self testing of Fig. 5 in detail;

Fig. 7 is a schematic cross-section of the eye enclosure 28 of Fig. 5 taken along the lines VII - VII;

Fig. 8 is a schematic isometric view, illustrating the optical testing unit of Fig. 5 in detail;

Fig. 9 is a is a schematic top view, illustrating the optical testing unit of Fig. 5 in detail;

Fig. 10 is a schematic cross-section and side view of the optical testing unit of Fig. 8;

Fig. 11 is a schematic isometric exploded view illustrating some of the components of the optical testing unit of Fig. 8 in detail;

Fig. 12 is a schematic exploded isometric view of the answer display unit of Fig. 10;

Figs. 13, 14 and 15 are schematic side views of the near/intermediate optical assembly and the line of sight deflecting unit of Fig. 9, illustrating the line of sight for far field, intermediate field and near field testing configurations, respectively;

Fig. 16 is a schematic top view of one of the slide assemblies of Fig. 9;

Fig. 17 is an isometric exploded view of one of the slide assemblies of Fig. 9;

Figs. 18 and 19 are schematic top views of the optical testing unit of Fig. 9 illustrating typical positions of the test pattern projection unit and of the right and left glare units during various testing stages;

Fig. 20 is a schematic functional block diagram illustrating the control unit of Fig. 9 in detail;

Figs. 21A, and 21B are schematic views illustrating two diff rent exemplary test images simultaneously presented to the left and right eyes, respectiv ly, of a subject undergoing a vertical phoria test using the optical testing unit of Fig. 8;

Fig. 21C is a schematic view illustrating the exemplary combined test image as seen by the subject undergoing the vertical phoria test of Figs. 21A and 21B

Fig. 22 is a schematic views illustrating an exemplary test image as seen by one of the eyes of a subject in a vision accuity test using the optical testing unit of Fig. 8;

Figs. 23A and 23B are schematic flow diagrams illustrating the control flow of vision testing performed by the system for automatic self testing of vision, in accordance with a preferred embodiment of the present invention; and

Figs. 24 - 29 are schematic flow diagrams illustrating the control flow of the vision acuity test, the lateral and vertical phoria test, the fusion test, the FOV test and the color vision test, respectively, performed by the system for automatic self testing of vision, in accordance with a preferred embodiment of the present invention.

Fig. 30 is a schematic pictorial illustration of an optical testing unit having an adjustable head-rest for allowing a subject wearing bifocal, multifocal or continuous focus eyeglasses to change the line of sight, in accordance with another preferred embodiment of the present invention; and

Fig. 31 is a schematic top view of an optical testing unit having a display unit, in accordance with yet another preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference is now made to Fig. 1 which is a schematic pictorial illustration of a system for automatically summoning, self-training, self testing and/or self tutoring system, constructed and operative in accordance with an embodiment of the present invention. Fig. 1 illustrates a local area network (LAN) based system which is particularly suitable for a work place. The system of Fig. 1 is also suitable to other environments, such as schools, police, army squads and the like.

System 250 comprises a main apparatus 251 for performing tests, training sessions and/or tutoring sessions and for controlling same, a supervisor

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control interface 252, a plurality of subjects summoning devices referenced 253 and a remote expert(s) apparatus 254. Main apparatus 251 comprises a control apparatus 256 and a plurality of testing/training and/or tutoring devices and testing/training and/or tutoring functionalities 258.

In operation described in detail with reference to Fig. 2 hereinb low, supervisor 252 sets control apparatus 256 to control a specific testing/training and/or tutoring session, control apparatus 256 summons subjects 255 to tak th testing/training and/or tutoring session using any testing/training/tutoring devices or functionalities 258 and then analyzes the test/tutoring session results in th control apparatus 256 itself, or with the assistance of remote experts 254.

It will be appreciated that functionalities 258 refer to any test or tutoring or training session embedded as a software application in system 250, such as the ones detailed hereinbelow.

Control apparatus 256 includes a main processor 260, a display 262, and a human interface 264, which can be implemented on display 262 as a touch screen or be an independent device, such as a keyboard or a mouse, a data storage device 266 and a printer 268

In the non-limiting illustrated embodiment, human interface 264 includes a display, a keyboard, an audio interface comprising a speaker and microphone 270, a personal identification device 272 which may include any combination of an electromagnetic card reader, a voice recognition device, a physical recognition device, such as a finger print analyzer, an iris analyzer or a face analyzer and an interface which in the non-limiting illustrated embodiment is a key-pad with four buttons 274, 275, 276 and 277. These devices may employ any suitable recognition method, such as pattern recognition. With these buttons, the subject can move through the screen options provided by control apparatus 256, using keys 274 and 275, select various options using key 276 and enter desired choices using key 277.

In the present non-limiting example, physical testing device 278 is a hearing testing device, physical testing device 280 is a vision testing device, physical testing device 282 is a heart testing device, physical testing device 284 is a spirometer and block 286 is an example of a logic testing device stored in the data storage 266, a safety regulation testing/tutoring functionality in the non-limiting example.

It will be appreciated that the devices and logic mentioned above are set for example only and numerous other devices and logics can be used. For

xample, a device for checking the alertness and the existence of agents reducing sam , such as drugs, medications, alcohol, toxins and lack of sleep operating to measure the stability of the subject while standing on a test platform and/or how fast the subject reacts to light and audio stimulations.

Physical testing devices 278, 280, 282 and 284, human interface 264, display 262, data storage device 266 and printer 268 are all connected to processor 260 which is operative to execute the control application of the present invention.

In the illustrated embodiment, main apparatus 251 is connected via any suitable LAN to supervisor 252 and to subjects summoning devices 255 and by any remote communication means, either direct (e.g. modem) or via a wide area network (e.g. INTERNET) to remote expert(s) 254.

In operation, described with reference to Fig. 2 and to the work place environment, a supervisor defines a test session or a tutoring session to be taken by all or part of the employees as indicated by step 290. Supervisor 252 may employ his own computer or the control apparatus 256 to define the test/training/tutoring session and if necessary the predetermined group of subjects.

Usually, data storage device 266 contains information on the predetermined group of people, each having a record which includes relevant personal data. However, if this data is not available in data storage 266, it may be transmitted thereto or keyed in. In the illustrated non-limiting example, data storage 266 will include information on each employee, the information including age status, medical status, qualifications status, etc. Data storage 266 will also include results of previous tests/tutoring sessions if available.

After a supervisor defines a test/tutoring session, control apparatus 256 operates to automatically summon subjects and to schedule the test/tutoring session therefore as indicated in step 292. Summoning may be in accordance with any suitable criteria, such as alphabetical order of employees, the results of previous tests, departments of the organization, non-appearances to previous tests and the like. Control apparatus 256 may also define a date by which all employees must take certain tests and/or tutoring sessions. Also, the subject may request of the system specific scheduling of his/her test.

Each employee is summoned as determined by control apparatus 256. In the illustrated embodiment, each subject has his own computer 255 connected to the main apparatus via a LAN, therefore the summoning can be electronic, in the

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form of an e-mail message appearing on the employees' screen. Howev r, in work places where employees do not have computer access an alternative summoning may be used. For example, printing summoning letters automatically by printer 268 and distributing manually.

Other electronic summoning methods may include using electronic billboards located in dominant locations in the workplace (e.g. entrance to a dining hall), via a pager or by an automatic audio message transmitted from system 256 via telephone.

It will be appreciated that in each work place the summoning mechanism is preferably defined in accordance with the notification means and procedures customarily used in the work place.

Preferably, but not necessarily, control apparatus 256 summons employees in accordance with the standard practices of the specific workplace, i.e. using internal e-mail, mail distribution boxes or the like.

If the subject shows up on schedule for his test/tutoring session as indicated by step 294, apparatus 256 will initiate an identification procedure indicated in step 296. However, if a subject fails to show up for his test/tutoring session (step 297), the system may either resummon him by rescheduling his test/tutoring session immediately, or after a few failures to attend, can notify the supervisor or declare a test failure, which may result in losing a qualification as determined by the supervisor.

As indicated by step 296, on the predetermined examination date, when the subject to be tested reports in, the processor 260 provides him with an instruction to perform an identification procedure using personal identification device 272.

It will be appreciated that the system may also allow non scheduled subjects to be examined according to a predetermined supervisor instructions.

It will also be appreciated that any suitable identification device or a combination thereof may be used to identify the subject, and to verify that he personally participates in the test/tutoring session. These may include any of or a combination of voice recognition, magnetic card identification, keying in a personal password with an employee number, visual identification using a vid o camera and the like, and/or other suitable identification devices.

In one embodiment, the system verifies periodically that the summoned subject is the one taking the test so as to avoid fraud. These v rifications may be carried out by any suitable means, such as continuous contact of the subject with

the test device, acquiring periodic images of the subject and/or any other acceptable method.

If the subject is not identified as indicated by step 298, the system may indicate same to a person who need not necessarily be the supervisor 252, who may authorize his identity, or can declare a test failure resulting in any of resummoning, lost of qualification and the like as described above.

In one embodiment, the system includes primary and secondary identification tests. For example, voice recognition, a video image of the subject, comparing it to his image in a data base, finger prints, iris identification and face recognition can be defined as primary tests while identification employing an identification card, a personal password or other personal details are defined as secondary tests.

In one embodiment, the primary tests are interchangeable, i.e. one is sufficient to provide verification of the subject. The secondary verifications require either one of the three methods or human supervisor intervention to start the test.

According to a first mode of operation, after the subject, also referred to as the subject, has completed the identifying procedure and his/her identity has been verified (step 299), the processor 260 initiates a system or test/tutoring session acquaintance inquiry as indicated by step 301, to ensure that the subject can perform the test or tests. The inquiry may include a pre-test examination so as to verify acquaintance with the test/tutoring session procedure and with devices or functionalities 258.

If the subject is not acquainted with the test, an acquaintance tutorial session takes place as indicated by step 302 followed by an acquaintance examination. If this pre-test examination is passed the process continues with the test at step 303.

If the subject fails to understand the test, a simpler, wider, or more detailed acquaintance tutoring is provided.

In one embodiment, the results of the acquaintance examination carried in step 303 define the level of the main test or tutoring session to be carried out.

Otherwise, the process continues at step 304 with a notification to the supervisor or with a test failure notice, resulting in re-summoning, losing qualification and/or the like as described hereinabove.

A test and/or tutoring session may now take place as indicated by step 303. In the non-limiting example described hereinbelow, the test is a yearly checkup for workers checking eye vision, hearing, cardiac functionality and th

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like as described hereinbelow.

Control apparatus 256 may initiate a first visual test and a second hearing test. After the apparatus has completed the hearing test, the processor provides the subject with instructions on how to conduct a third test. In the present example the third self testing procedure is a cardiac test similar to an ECG test. The processor 260 provides the subject with instructions on how to use physical testing devices 282 and performs a fully automatic heart monitoring and testing procedure.

For each test, the test results are obtained by control apparatus 256 and the processor 260 analyzes the test results which were provided in the three tests and determines the physical condition of the employees as indicated by step 305. Analysis can also be done elsewhere by an expert using apparatus 254 who receives the test or tests results, analyzing same and providing a final answer to control apparatus 256. Similarly to a telemedicine system, the expert using apparatus 254 may also receive test results during the test itself and may provide feedback to control apparatus 256 which may modify the test in accordance therewith.

If the test/tutoring session is successful as inquired in step 306, the processor adds this analysis to the record of the employee in data storage device 266 as indicated by step 307. The processor can compare the results of the physical condition of the employee with historical data relating to previous tests of the subject, so as to determine whether the health of the subject has changed for the better or the worse. According to the updated record of the subject, the processor can perform further analysis and determine medical recommendations, which can be provided to the subject, to the expert using apparatus 254, to the physician of the subject, or to a staff manager or supervisor in any suitable way as described above.

Alternatively, or in addition thereto, the results, the bottom line recommendations or both can be transmitted to the supervisor (step 308) or a test success certificate can be provided (step 309).

In one embodiment, the expert receives all test result information including confidential personal details, whereas the supervisor receives only a final result of the test.

If the subject fails the test or does not complete it, a test failure indication is provided to the supervisor as indicated by step 310 and/or the qualification of the subject is not granted as discussed above. Similar actions are taken if the

system detects deliberate failure.

D liberate failure can be detected by any suitable m thod, such as by inconsistency in the results obtained in similar tests. In one embodiment, control apparatus 256 generates a number of tests of similar level to allow comparison between subjects and for the same subject being presented with two different tests of the same level.

In any scenario, test success or failure, a re-scheduling and re-summoning operation may be initiated to repeat the process immediately in case of test failure or within a predetermined time frame, or if the test is successful to optionally summon the subject to a more advanced test or tutoring session.

According to a second mode of operation, the apparatus instructs the subject to conduct simultaneously a plurality of medical tests. According to the present embodiment, the processor 260 provides the subject with instructions to wear and use physical testing devices 280, 282, and 284. Then, the processor 260 conducts, simultaneously, a heart condition test, using heart testing device 282, a breathing test using spirometer 284 and a visual test using devic 280. Thus, the system saves time, as well as, obtains an overall observation of sev ral interconnecting bodily systems.

According to a third mode of operation, the apparatus conducts an examination of a plurality of subjects, medical examination as a non-limiting example . A first subject using physical testing device 278, a second subject using physical testing device 280, a third subject using physical testing device 282 and a fourth subject using physical testing device 284. According to this mode, the apparatus makes full use of all of its resources.

In an alternative embodiment, the system may include a plurality of the same testing devices so as to conduct simultaneous testing to a plurality of subjects.

Reference is now made to Fig. 3 which is a schematic illustration of a self-testing, self-training and/or self-tutoring system, including a plurality of testing units for performing medical testing, training and/or tutoring, constructed and operative in accordance with another preferred embodiment of the invention. The system 300 of Fig. 3 is particularly suitable for work environments having a plurality of geographically separated workplaces such as a corporation having a plurality of factories geographically separated from each other and from the corporation headquarters. However, the system 300 can also be suitable for other typ s of environments such as government institutions, armies, insurance

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companies and the like.

The syst m 300 includes a plurality of testing units 352, labeled 352A - 352N. Each of testing units 352 is connected to a control unit 365 though a network 376. The network 376 can be a LAN, a WAN, a satellite communication network, a wireless communication network or any combination thereof. The network 376 may also include any other type of public or private communication network. The control unit 365 includes an automatic summoning unit 351 and an automatic notification/ data storage/ reporting/ reexamination scheduling unit 366. The control unit 365 may also include a supervisor 374.

The system 300 includes a plurality of subjects 355, labeled subject A -N. The subjects 355 may be divided into subgroups of subjects (not shown) each of the subgroups of subjects generally located near at least one of the testing units 352. The system 300 may also include remote expert(s) 372 communicating with the control unit 365 and the testing units 352 through the network 376, and a supervisor 374 linked to the network 376 .

The testing unit 352A includes an automatic identification unit 354 for identifying a subject , automatic tutoring and /or training units 356 and 358, automatic testing devices 360 and 362, and an automatic diagnosis and interpretation unit 364. It is noted that, while the testing unit 352A includes two automatic tutoring and/or training units and two automatic testing devices, other testing units may include any number of tutoring/ and or training units and automatic testing devices (not shown)

It is noted that each of the testing units 252 may operate to test or tutor or train one or more of the subjects as disclosed hereinabove for the system 250. Thus, The testing units 352 may function similarly to the main apparatus 251 of Fig. 1 as disclosed hereinabove and illustrated in Fig. 2. Thus, the automatic summoning unit 351 may summon different groups of subjects to be test d or tutored in different testing units as disclosed hereinabove for the control unit 256 of Fig. 1.

It is noted that, the automatic diagnosis and interpretation unit 364 of each of the testing units 352 may communicate the results of diagnosis and interpretation directly to the control unit 365, or may alternatively communicate the raw test results to the remote expert(s) 372 for diagnosis and interpretation. The interpretation and diagnosis of the expert(s) 372 may then be communicated from the remote expert(s) 372 to the control unit 365 for storage, reporting, notification and reexamination scheduling.

It is noted that the control unit 365 may b implemented as software operating on a single computer (not shown) connected to the n twork 376 but may also be implemented as different software modules operating on a plurality of computers (not shown) in a distributed manner. Similarly the supervisor 374 may operate from any computer, terminal or workstation linked to the network 376.

It is further noted that, the automatic notification unit 366 may gen rate reports by using an output device such as a network printer or a dedicated print r or any suitable output device. The reports may also be e-mailed or electronically communicated to be locally output in hard copy or in an electronic report at any of the localities at which one or more of testing units 352 is physically situated.

It will be appreciated that the apparatus of Figs. 1 and 3 can perform a plurality of additional tests grouped according to specific needs and applications such as:

- Hearing and blood pressure in a noisy environment.
- Visual acuity vision and response time, for professional drivers.
- Blood chemistry, for example glucose, cholesterol, etc., for high risk groups.
- Blood pressure and ECG for cardiac patients.
- Visual memory, depth perception and response time for pilots.
- Alertness, stability and equilibrium testing.

According to yet another embodiment of the present invention, the tutoring includes:

a. tutoring in new assignments that the employee needs to perform during his work.

b. tutoring using new software introduced to the company.

c. tutoring in the company regulations (e.g., safety regulations)

d. tutoring in areas of responsibility (e.g., introduction to marketing for an R&D engineer).

Furthermore, it is important to indicate that the operations of scheduling the tests, identifying the subject, instructing, training and testing, analyzing and classifying the test results, producing personal as well as statistical reports, are all provided automatically by the systems 250 and 300. All of th se operations are performed according to predetermined criteria provided by the supervisor 252 or 374, respectively.

It will be appreciated that although the systems 250 and 300 are intended to operate in a full automatic manner, they may be adapted for override by a professional operator such as a system manager.

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reference is now made to Fig. 4A which is a schematic block diagram illustrating a system for automatic self testing of vision, in accordance with a preferred embodiment of the present invention. The system 1 includes an optical testing unit 2 for performing visual tests. The system 1 also includes a computer 4 suitably connected to the optical testing unit 2 for controlling the operation of the optical testing unit 2. The computer 4 also processes and stores the test results of the subjects. The computer 4 can be a personal computer or any other type of suitable computer. The computer 4 also includes a storage device (not Shown) for storing the results of the tests of different users. The storage device can be a magnetic storage device such as a hard disk, an opto-magnetic storage device, an optical storage device or any other suitable storage device having a fixed or a removable storage media. The computer 4 thus creates and maintains a database which includes information about subjects such as various possible identifying data and test results data. The computer 4 also includes a display and a sound card and speakers (not shown) which are used for audio-visual interaction with the user of the system 1. The system 1 can thus provide instructions to the user which is being self-tutored or self-tested. The display is also used for presenting certain test patterns. For example, the test patterns in the test for color vision may be presented to the subject on the computer display. The system 1 further includes a user interface 8 suitably connected to the computer for receiving user input during self testing. The user interface enables the user to select answers to the test patterns which are presented to his eyes by the optical testing unit.

The system 1 also includes an identifying unit 6 for identifying the user prior to administering an automatic self-tutoring and/or self-testing session to the user. The identifying unit 6 includes at least one device for providing an identification of the user. For example, the identifying unit 6 may include a keyboard or keypad for keying a password. Thus, the user may identify himself by simply keying in a password or code number or any suitable key combination for identifying himself. The identifying unit 6 may include a pointing device such as a mouse for selecting an item from a group of items such as text lines or icons on the computer display. The identifying unit 6 may include an electromagnetic card reader for reading a magnetic card with the identification of the user. The identifying unit 6 can also include a voice recognition device for identifying the voice signature of the user. The identifying unit 6 can also include a video camera for acquiring a video image of the face of the user that can be

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stored with the test results or printed on a test report for verification of the identity of the tested user. The identifying unit 6 can also include a face analyzer using pattern recognition techniques. The identifying unit 6 can also includ a finger print analyzer. The identifying unit 6 can also include a an iris analyzer for identifying unique patterns in the iris of the user. The identifying unit 6 may include a retinal pattern analyzer for identifying the user based on unique features in his retinal pattern.

It is noted that, in accordance with a preferred embodiment of the present invention, the identifying unit 6 can include any single one of the devices for providing identification disclosed hereinabove or any combination of these devices. Thus the system 1 can be configured to provide different degrees of reliability of the identification of the user depending on the nature of the device or device combinations which are included in the identifying unit 6. For example, a identifying unit 6 which includes only a keyboard and code keying can be configured in cases where a relatively low degree of reliability in identification is required. In contrast, an identifying unit 6 which includes a combination of a voice recognition device, a retinal pattern analyzer and a keyboard for keying in a users code can be configured in a case were a high degree of reliability of user identification is required.

The computer 4 of Fig. 1 is also connected to an output device 3, such as a printer or any other suitable output device for producing a report or a hard copy of the test results.

It is noted that for a better understanding, like components are designated by like reference numerals throughout the various figures.

Reference is now made to Fig. 2 which is a schematic block diagram illustrating a system for automatic self testing of vision connected to a second computer, in accordance with another preferred embodiment of the present invention. The system 1 of Fig. 2 is connected to the second computer 12 by a suitable communication line 10. The system 1 of Fig. 2 can also communicate with the computer 12 through a dedicated communication line, a LAN, a WAN or any other suitable wired or wireless communication method. The computer 4 can thus communicate the results of the tests which are administered to a user for updating a database stored on the second computer 12. The computer 4 can also acc ss the database stored on the second computer 12 for obtaining

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data such as the results of previous tests (user test history data) taken by a user which is identified by the identifying unit, and various identification data such as retinal patterns, voice signatures, user specific codes and other suitable user identifying data.

It is noted that the second computer 12 can be any suitable type of computer such as a microcomputer, a minicomputer, a mainframe computer or any other suitable computer.

Reference is now made to Fig. 3 which is a schematic block diagram illustrating a system for automatic self testing of vision connected to a local area network, in accordance with another preferred embodiment of the present invention. The system 1 of Fig. 3 is connected to a local area network (LAN) 14 by a suitable communication line 10. The system 1 can thus use the resources (not shown) of the LAN 14 such as local or remote printers for printing the test results, storage resources for accessing and updating a user database and computational resources for computationally intensive tasks such as retinal pattern analysis.

Reference is now made to Fig. 4 which is a schematic block diagram illustrating a system for automatic self testing of vision connected to a wide area network (WAN) 18 and to a tele-medicine center 20 through the public switched telephone network (PSTN) 16, in accordance with yet another preferred embodiment of the present invention. The system 1 is connected to the PSTN 16 by a suitable communication link 22. The communication link 22 can be a modem (not shown) suitably connected to the computer 4 and connected to the PSTN 16 by a telephone line or any other suitable communications link. The system 1 is also connected to a tele-medicine center 20 through the PSTN 16.

It is noted that while Fig. 4 discloses only one system for automatic self testing of vision which is connected to a WAN and a tele-medicine center, many systems for automatic self testing of vision can be similarly connected with a central facility (not shown). In one non-limiting example a plurality of systems for automatic self testing of vision placed in a plurality of geographically separated workplaces can communicate with a tele-medicine center located at the company's headquarters where the central database of the company is located.

It is noted that, while the user interface 8 of the system 1 of Figs 1-4 is shown to be connected to the computer 4, it can also be suitably connected to the optical testing unit 2.

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Reference is now made to Fig. 5 which is a schematic isom tric vi w illustrating the system 1 of Figs. 4A - 4D in accordance with a preferred embodiment of the present invention. The computer 4 includes a display 5 and a keyboard 7. The keyboard 7 together with the computer 4 function as the identifying unit 6 of Fig. 1 as disclosed hereinabove. The optical testing unit 2 includes a light-occluding housing 24 which is attached to a swivel base 26. The housing 24 can be horizontally rotated and also tilted relative to the swivel base 26 for adapting its position to comfortably accommodate the head of a user 22. The optical testing unit 2 further includes a head rest 25 attached to the housing 24 and an eye-enclosure assembly 28 attached to the head rest 25. The eye-enclosure assembly includes two eyepieces 36. The user interface 8 of the system 1 includes three buttons 30, 32 and 34. The buttons 30 and 32 are used to select the answer for a test image and the button 34 is used to enter the selected answer as is disclosed in detail hereinbelow. The buttons 30, 32 and 34 are color coded and may also have unique shapes and identifying text to help distinguish them for color blind users. The buttons 30, 32 and 34 are also arranged on the user interface in a unique distinct geometrical arrangement. In a non-limiting example, button 30 may be green and rectangular, button 32 may be red and triangular and button 34 may be yellow and circular. When the us r interface 8 is held such that the button 34 faces towards the user 22, button 32 is on the right side of the user interface 8 and button 34 is on the left side of the user interface 8.

It is noted that, the buttons 30, 32 and 34 may have other suitable colors, text and shapes and may also be differently arranged on the user interface 8.

The user 22 initially keys a user identification code on the keyboard 7. After the computer 4 has identified the user, the computer provides an audio-visual self training tutoring session for the user 22 by displaying textual and visual explanations and audio (voice) instructions instructing the user 22 how to use the user interface 8 and how to take a self testing session. The instructions are presented on the display 5 and by providing audible instructions and explanations using a sound card and suitable speakers (not shown). Aft r the self tutoring session is ended the computer presents the visual tests. The user 22 leans his forehead on the head-rest 25 such that his eyes are prop rly positioned relative to the eyepieces 36 for viewing the test images which are presented by the optical testing assembly 2. The user uses the buttons 30,32 and 34 of the user interface 8 for selecting answers and for communicating the

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selected answers to the computer 4 while his forehead is in contact with the head rest 25.

Reference is now made to Fig. 6 which is a schematic isometric view illustrating of the eye enclosure 28 of Fig. 5 in detail. The eye enclosure 28 includes two eyepieces 36 for viewing the test images. Each of the eyepieces 36 includes a single optical assembly 37. The eye enclosure 28 has a depression 55 positioned between the two eyepieces 36 for accommodating the nose of the user 22. The eye enclosure 28 further includes a head presence sensor including a head presence emitter 38 and a head presence detector 40 for sensing the presence or absence of a head of a user within the eye enclosure. In a non-limiting example the head presence emitter 38 is an infra-red light emitting diode and the head presence detector 40 is an infra-red light sensitive detector. When the users head is positioned within the eye-enclosure, the head blocks the path of the infra-red light beam emitted by the head presence emitter 38 and prevents it from reaching the head presence detector 40. The signal from the head presence detector 40 is communicated to the computer 4 and is used for determining whether a test can be started. The signal from the head presence detector 40 is also used to detect attempts of fraud by the user since an attempt to remove the head from the eye-enclosure during the test will be detected and recorded.

It is noted that, the head presence emitter 38 and the head presence detector 40 can also be an ultrasound emitter and a directional ultrasound microphone or any other type of detector and emitter suitable for detecting the presence or absence of a user head without interfering with the visual performance of the user 22. Additionally, the head presence sensor can be any other suitable type of sensor such as a proximity sensor, or a contact sensor attached to the eye enclosure 28 or to the head rest 25 in a suitable position.

The eye enclosure 28 further includes eight light sources L0, L1, L2, L3, L4, L5, L6 and L7. The group of light sources L0, L1, L2 and L3 is used in testing the horizontal field of view (FOV) of the right eye of the user 22 and the group of light sources L4, L5, L6 and L7 is used in testing the horizontal field of view (FOV) of the left eye of the user 22 as is disclosed in detail hereinbelow. In accordance with one preferred embodiment of the present invention, the light sources L0, L1, L2, L3, L4, L5, L6 and L7 are LEDs emitting visible light. It is

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noted that, the light sources L0, L1, L2, L3, L4, L5, L6 and L7 can be any other suitable visible light sources.

Referenc is now made to Fig. 7 which is a schematic cross-section of the ey enclosure 28 of Fig. 5 taken along the lin s VII - VII. The ey enclosure 28 includes two optical elements 37 suitably mounted in the two eyepieces 36. The light sources L0, L1, L2, L3, L4, L5, L6 and L7 are generally directed towards the general position of the eyes 39 of the user 22. For the sake of clarity of illustration, the wires connected to the light sources L0, L1, L2, L3, L4, L5, L6 and L7 for supplying them with electrical power are not shown. It is noted that, while in a non-limiting example of the present invention the optical elements 37 are lenses, other suitable optical elements can be used.

Reference is now made to Fig. 8 which is a schematic isometric view, illustrating the optical testing unit 2 of Fig. 5 in detail. The optical testing unit 2 is connected to a power supply unit 23. It is noted that, while in accordance with a preferred embodiment of the present invention, the power supply unit 23 is external for freeing up as much space as possible inside the housing 24, the power supply unit of other embodiments may be internally attached within the housing 24.

Reference is now made to Fig. 9 which is a schematic top view, illustrating the optical testing unit 2 of Fig. 5 in detail. The optical testing unit 2 includes the housing 24 and a test pattern projection unit 150 attached to the housing 24 for projecting test patterns onto the eyes of the user 22. The optical testing unit 2 further includes an answer display unit 140 attached to the housing 24 for projecting an answer image onto the eye of the user 22. The test pattern and the answer pattern together form a test image as disclosed in detail hereinafter. The optical testing unit 2 further includes a right glare illumination units 100 and a left glare illumination unit 120 attached to the housing 24 for providing glare-like illumination. The optical testing unit 2 further includes a lin of sight deflecting unit 80 attached to the housing 24 for deflecting the line of sight of viewing the test pattern and answer pattern by users wearing bifocal, multifocal and progressive focus eyeglasses. The optical testing unit 2 furth r includes a near /intermediate field optical assembly 60 for adapting the testing to near field like and intermediate field like viewing conditions. The optical testing unit 2 also includes a removable filter 59 disposed between the near /intermediate field optical assembly 60 and the eye enclosure 28. The filter 59 can be a chromatic filter, a neutral density filter or any other suitable type of

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filter. The filter 59 may be inserted or removed for performing certain vision test t sts. A chromatic filter may be inserted to produce a t st image having a certain color, for example a chromatic filter that produces a red test image may be used for a test simulating vision in a photo lab darkroom. A neutral density filter may be used for controlling the contrast. The optical testing unit 2 further includes a controlling unit 35 for controlling the operation of the components of the optical testing unit 2.

Reference is now made to Figs 10 and 11. Fig. 10 is a schematic cross-section and side view of the optical testing unit 2 of Fig. 8. Fig. 11 is a schematic isometric exploded view illustrating some of the components of the optical testing unit 2 of Fig. 8 in detail. It is noted that, for the sake of clarity of illustration, some of the components of the optical testing unit 2 are not shown or only partially shown in Fig. 11. The test pattern projection unit 150 includes a projector housing 151. The test pattern projection unit 150 also includes two sliders 152 attached to the projector housing 151. The sliders 152 slide on two rails 153 attached to the housing 24. Thus, the test pattern projection unit 150 can slide along the rails 153 in the directions indicated by the double head d arrow labeled 159. The test pattern projection unit 150 further includes a spar rack 157 attached to the projector housing 151 and a left/right motor 155. Th left/right motor 155 is attached to the housing 24. The left/right motor 155 is attached to a spar gear 159. The spar gear 159 is engaged with the spar rack 157. When the left/right motor 155 rotates clockwise or counter-clockwise (as viewed from the general direction of the eye enclosure 28) it moves the test pattern projection unit 150 to the right or to the left along the direction of the double headed arrow marked 159, respectively.

The test pattern projection unit 150 further includes a slide rotating assembly 154. The slide rotating assembly 154 includes a rotating member 160, a ring-like member 156 and a plurality of slide assemblies 161. The slide assemblies 161 are attached to the rotatable member 160 and to the ring-like member 156 by screws 162. Each of the slide assemblies 161 has four test patterns 181, 182, 183 and 184 as is disclosed in detail hereinbelow. It is noted that, although the four test patterns of each slide assembly 161 can be different from all other test patterns of other slide assemblies 161, for the sake of clarity, the test patterns on each of the different slide assemblies 161 are referred to as test patterns 181, 182, 183 and 184 solely to indicate their relative positions on the slide assembly 161, thus, two differ nt test patterns on two different slide

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assemblies 161 may both be referred to as test pattern 181 only to indicate that they are th rightmost test pattern on both slides when viewed fron the general direction of the eyepieces 36.

The slide rotating assembly 154 further includes a first pulley 158 attached to the rotatable member 160, a slide rotating motor 163 attached to a second pulley 164, and a transmission belt 165 for rotatably coupling th first pulley 158 with the second pulley 164. The test pattern projection unit 150 also includes the reset sensor 197 and a pair of position sensors 199 for determining the position of the ring like member 156 and thus the identity of the slide positioned in front of an opening 160 in the projector housing 151.

Each of the slide assemblies 161 can be moved to a position in front of the opening 166 in the projector housing 151 by suitably activating the slide rotating motor 163 for rotating the slide rotating assembly 154. When a select d slide assembly 161 is positioned in front of the opening 166, the left/right motor 155 can be activated to move the test pattern projection unit 150 along the direction indicated by the double headed arrow referenced 159 until a selected pair of test patterns is aligned with the optical axes 225 and 226.

The test pattern projection unit 150 further includes a slide illuminating unit 167 for illuminating the slide assemblies 161 to project test patterns onto the eyes of the user 22. The slide illuminating unit 167 includes a supporting member 168 attached to the housing 24 and protruding through the opening in the ring-like member 156 into the slide rotating assembly 154. The slide illuminating unit 167 also includes a housing 169 attached to the supporting member 168 and two light sources 170 and 171 suitably attached within the housing 169. The light sources 170 and 171 are suitably connected to a power source (not shown) and can be turned on and off separately. The light sources 170 and 171 can be an incandescent light bulb or any other suitable light source.

Reference is now made to Fig. 12 which is a schematic exploded isometric view of the answer display unit 140 of Fig. 10. The answer display unit 140 includes an illumination unit 141, a combiner mirror 142 inclined at roughly 45 degrees to the plane of the illumination unit 141 and a slide holder 143 attached to the illumination unit 141.

The slide holder 143 includes a diffuser 144 for diffusing the light of the illumination unit 141, a transparent cover plate 146 and an answer slide 145 disposed between the diffuser 144 and the cov r plate 146. The diffuser 144 is

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made of frosted glass or any other suitable diffusing material. The transparent cover plat 146 can be made of any suitable transparent material such as glass or clear plastic. The answer slide 145 has sixteen answer images 147 arranged in two groups of eight answer images. Each group of eight answer images includes two staggered rows of four answer images. Each one of the groups of eight answer images can project an answer image to one of the eyes of th user 22. The answer slide 145 has a dark background. The answer slide 145 can be made from a sheet of photographic film on which the answer images are photographed. The answer slide 145 can also be made from a sheet of transparent material such as clear plastic or glass onto which the answer images are suitably printed.

The illumination unit 141 is a block of plastic, metal, or any other suitable material, having sixteen holes 148 therewithin. The illumination unit 141 further includes sixteen light sources 149 attached within the holes 148. The light sources 149 can be any suitable light sources such as LEDs or incandescent light bulbs. It is noted that, for the sake of clarity of illustration, the wires connecting the light sources 149 to the control unit 35 are shown only for one of the light sources 149. When the slide holder 143 is attached to the illumination unit 141, the answer patterns 147 overly the holes 149 so that when one of the light sources 149 is turned on, the light from the light source 149 passes through the answer image overlying it and is reflected by the combiner mirror 142 towards one of the eyepieces 36 along the optical axis corresponding to that eyepiece.

It is noted that, the two groups of eight answer images are comprised of matched answer images. However only one sub-group of four answer images is projected to one eye at a time. The two groups of answer images are different and are each adapted to function with different types of tests as is described in detail hereinafter.

Turning back to Figs. 10 and 11, the near/intermediate field optical assembly 60 includes a U shaped bracket 61 attached to the housing 24, a near optical adapter 68 rotatably attached to the bracket 61 and a near motor 65 attached to the near optical adapter 68 for rotating the near optical adapter 68. The near optical adapter 68 includes a rotatable vane 62 and two optical assemblies 66 attached to the vane 62. The optical assemblies 66 produce an apparent convergence of both optical axes which corresponds to a desired predetermined image distance. The optical assemblies 66 also produce th

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r quired magnification corresponding with th predetermined apparent image distance. In accordanc with one preferred embodiment of the present invention, each of the optical assemblies 66 includes a lens 66A which contributes the required optical power and a prism 66B for deflecting the light to produce an apparent convergence which is appropriate for the required near field testing conditions.

The near motor 65 can rotate the near optical adapter 68 so that the optical assemblies 66 are suitably aligned relative to the eyepieces 36 for simulating near field vision conditions. The near optical adapter 68 can be rotated out of alignment with the eyepieces 36 to a position indicated by dashed lines 73. The intermediate/near field optical assembly 60 further includes a member 71 and two position sensors 69 and 70 for sensing the position of the member 71 for detecting the positioning of the near optical adapter 68.

The near/intermediate field optical assembly 60 further includes an intermediate optical adapter 69 rotatably attached to the bracket 61 and an intermediate motor 64 attached to the intermediate optical adapter 69 for rotating the intermediate optical adapter 69. The intermediate optical adapter 69 includes a rotatable vane 63 and two optical assemblies 74 attached to the vane 63. The optical assemblies 74 produce an apparent convergence of both optical axes which corresponds to a desired predetermined "intermediate" image distance. The optical assemblies 74 also produce the required magnification corresponding with the predetermined apparent intermediate image distance. In accordance with one preferred embodiment of the present invention, each of the optical assemblies 74 includes a lens 74A which contributes the required optical power and a prism 74B for deflecting the light to produce an apparent convergence which is appropriate for the required intermediate field testing conditions.

The intermediate motor 64 can rotate the intermediate optical adapter 69 so that the optical assemblies 74 are suitably aligned relative to the eyepieces 36 for simulating intermediate field vision conditions. When the intermediate optical adapter 69 is rotated out of alignment with the eyepieces 36 and the near optical adapter 68 is also rotated out of alignment with the eyepieces 36 to a position indicated by dashed lines 73, the viewing conditions simulate far field vision conditions. The intermediate/near field optical assembly 60 further includes a member 76 and a position sensor 75 that together with the position

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sensor 70 sense the position of the member 76 for detecting the positioning of the intermediate optical adapter 69.

Thus, by suitably activating the motors 64 and 65 the vision conditions the optical testing unit 2 can be adjust d for far field, near field and an intermediate field vision testing.

It is noted that, while the optical assemblies 66 and 74 are shown to be configured as a lens plus prism combination, other optical configurations can be used. For example, the optical assemblies 66 and 74 can be decentered optical elements which combine power with deflection.

The line of sight deflecting unit 80 includes a bracket 81 attached to the housing 24, a line of sight adapter 82 rotatably attached to the bracket 81 and a line of sight deflecting motor 85 for rotating the line of sight adapter 82. The line of sight adapter 82 includes a vane 82 and two deflecting elements 86 such as prisms or any other suitable deflecting elements attached to the vane 83 for deflecting the line of sight of viewing the test patterns and answer patterns. The vane 82 is attached to the line of sight deflecting motor 85 enabling the deflecting elements 86 to be rotated in and out of alignment with the eyepieces 36. This arrangement enables users wearing bifocal, multifocal or progressive focus eyeglasses to undertake the test without having to readjust their head angle and position during the switching of testing from near field to far field or intermediate field vision conditions.

Reference is now made to Figs.13, 14 and 15 which are schematic sid views of the near/intermediate optical assembly 60 and the line of sight deflecting unit 80 illustrating in detail the line of sight for far field, intermediate field and near field testing configurations, respectively. Fig. 13 illustrates the optical assemblies 66 and 74 and the deflecting elements 86 positioned out of the optical axis 75. In this configuration the testing simulates the far field viewing condition and the optical axis 75 coincides with the line of sight of the user. Fig 14 illustrates the deflecting elements 86 and the optical assemblies 66 positioned out of the optical axis 75 and the optical assemblies 74 of the intermediate optical adapter 69 positioned within the optical axis 75. In this configuration the testing simulates the intermediate field viewing condition and the optical axis 75 coincides with the line of sight of the user. Fig. 15 illustrates the optical assemblies 74 positioned out of the optical axis 75 and the optical assemblies 66 and the deflecting elements 86 positioned within the optical axis 75. In this configuration the testing simulates a near field viewing condition

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which is suitable for a subj ct wearing bifocal, multifocal, or continuous focus eyeglasses. The line of sight 77 in this condition is deflect d relative to th optical axis 75, enabling a user wearing bifocal, multifocal or progressive focus eyeglasses to undergo the test without having to substantially move his head from the position assumed during the far field testing.

It is noted that, if the deflecting elements 86 of Fig. 15 are rotated out of alignment with the optical axis 75 (not shown), the resulting configuration simulates near field vision test conditions which are suitable for testing a subject which is not wearing eyeglasses. It is further noted that, for the sake of clarity of illustration, Figs. 13, 14 and 15 show only the optical components necessary for demonstrating the various configurations along the optical axis 75.

Returning to Figs. 10 and 11, the right glare illumination unit 100 includes a rotatable platform 102 attached to a motor 103. The right glare illumination unit 100 further includes a light source 105 and a reflector 101 attached to the platform 102 for reflecting the light from the light source 105 to create conditions similar to glare during the vision under glare condition test. The right glare illumination unit 100 also includes a baffle 104 for blocking a portion of th light from the light source 105 from directly reaching the eyepieces 36 When the light source 105 is switched on, the light is reflected from the reflector 101, creating glare like conditions. The left glare illumination unit 120 is similar in construction and operation to the right glare illumination unit 100 except that it is constructed as a mirror image of the right glare illumination unit 100.

It is noted that, while the glare illumination units 100 and 120 are configured as shown in Figs. 10 and 11, other configurations are possible. For example only one glare illumination unit can be used by placing it in a position above the eyepieces 36 (not shown) and by rotating the single glare unit downward for providing glare-like conditions and upwards for minimizing reflections of stray light during tests requiring no glare light.

Reference is now made to Figs. 16 and 17. Fig. 16 is a schematic top view of one of the slide assemblies 161 of Figs. 9-11. Fig. 17 is an isometric exploded view of one of the slide assemblies 161 of Figs. 9-11. In accordance with a preferred embodiment of the present invention, the slide assembly 161 includes a diffuser plate 190 made from a light diffusing material such as frosted glass, light diffusing plastic or any other suitable light diffusing material. The slide assembly 161 further includes a transparent cover plate 192 made from glass, plastic or any other suitable transparent mat rial. The slide ass mbly

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161 also includes a test pattern sheet 191 disposed between the diffuser plate 190 and the cover plate 192. The test pattern sheet 191 is a sheet of photographic film on which four test patterns 181, 182, 183 and 184 are photographed. The test pattern sheet 191 can also be a thin transparent sheet of material such as plastic or any other suitable material on which four test patterns 181, 182, 183 and 184 are printed. In accordance with another preferred embodiment of the present invention, The test patterns can be directly photographed or printed on the cover plate 192 obviating the need for the test pattern sheet 191.

The slide assembly 161 can be attached to the rotatable member 160 and the ring like member 156 of Fig. 11 by screws 162 passing through the holes 193.

Reference is now made to Figs. 18 and 19 which are schematic top views of the optical testing unit 2 illustrating typical positions of the test pattern projection unit 150 and the right and left glare illumination units 100 and 120 during various testing stages.

Fig. 18 shows the test pattern projection unit 150 in a position which places the test patterns 182 and 184 in the optical axes 226 and 225, respectively, of the right and left eyepieces 36. In this position the user 22 can view the images projected from the test patterns 182 and 184.

The glare illumination units 100 and 120 are shown in a first position wherein the platforms 102 and 122, respectively, are rotated in a direction away from the optical axes 226 and 225, respectively so as to minimize the reflection of stray light into the eyepieces 36. In the first position the light sources 105 and 125 are turned off.

Fig. 19 shows the test pattern projection unit 150 in a position which places the test patterns 181 and 183 in the optical axes 226 and 225, respectively, of the right and left eyepieces 36. In this position the user 22 can view the images projected from the test patterns 181 and 183. This arrangement wherein each slide assembly 161 is used for projection of two pairs of test pattern by changing the position of the test pattern projection unit 150, doubles the number of test patterns that can be presented to a user 22 relative to the number of test patterns that can be presented by the prior art vision testing apparatus disclosed by Griffin et al. This is useful since the optical testing unit 2 of the present invention is based on presenting the user 22 with only one single test pattern which is selected at random from the available test

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patterns so as to minimize the possibility of fraud by memorizing the sequence of the test patterns in the prior art tests.

It is noted that, while each of the slide assemblies 161 of Figs. 16 and 17 is shown to have four test patterns, in other embodiments of the present invention, the slide assemblies may include a higher number of test patterns organized as matching pairs which will be aligned with the eyepieces 36 by suitably positioning the slide projection assembly 150. For example, the slide assemblies may include six test patterns arranged in three pairs. Such embodiments will enable a higher number of test pattern to be used in testing.

The glare illumination units 100 and 120 of Fig. 19 are shown in a second position wherein the platforms 102 and 122, respectively, are rotated in a direction towards the optical axes 226 and 225, respectively so as to reflect light from the light sources 105 and 125 to simulate glare conditions. In the second position the light sources 105 and 125 are turned on.

Reference is now made to Fig. 20 which is a schematic functional block diagram illustrating the control unit 35 of Fig. 9 in detail. The control unit 35 includes a processor 220 for controlling the left/right motor 155, the slide rotating motor 163, the line of sight deflecting motor 85, the near field motor 64, the intermediate field motor 64, the left glare unit motor 123 and the right glare unit motor 103. The processor 220 is also connected to the reset sensor 197, the two position sensors 199A and 199B and to sensors 202, 204, 206, 208 and 210 for receiving data on the position of the various motors. The processor 220 is also connected to the current sensors 214 216 and 224 for sensing the current flowing through the light sources 105,170 ,171 and 125, respectively for determining their intactness and for adjusting the light intensity of the light sources 170 and 171 of the slide illumination unit 167. The processor 220 is also connected to the FOV testing unit 218 which includes the light sources L0, L1, L2, L3, L4, L5, L6 and L7, of the eye enclosure 28, for controlling the turning on and off of the light sources during the FOV test. The processor 220 is also suitably connected to the head presence detector 40 and to the head presence emitter 38 for detecting the presence or absence of the head of the user 22 within the eye enclosure 28 during the test session. The processor 220 is also suitably connected to a bidirectional communications interface for bidirectionally communicating with the computer 4. The bidirectional communications interface can be an RS-232 interface or any suitable type of communications interface.

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The processor 220 is also suitably connected to the answer display unit 140 for controlling the light sources 149.

Reference is now made to Figs. 21A, 21B, 21C and 22. Figs. 21A, and 21B are schematic views illustrating two different exemplary test images 230A and 230B which are simultaneously presented to the left and right eyes, respectively, of a subject undergoing a vertical phoria test using the optical testing unit of Fig. 8. Each of the test images 230A and 230B includes a single test pattern which is projected by the test pattern projection unit 150 of Fig. 9, and an answer pattern which projected by the answer display unit 140 of Fig. 9. Test image 230A includes the test pattern 232A and the answer image 234A, and test image 230B includes the test pattern 232B and the answer image 234B. The answer pattern 234A includes four patterns 235A, 236A, 237A and 238A, and the answer pattern 234B includes four patterns 235B, 236B, 237B and 238B.

It is noted that, during vision tests, an answer pattern is projected only to a single eye. When only one eye is tested, the answer pattern is projected to the eye under test.

One of the four patterns of the projected answer that is projectedin a test will be highlighted. The highlighting is done by blinking performed by intermitently turning on and off the appropriate light sources 149 under the appropriate answer patterns 147. However, the highlighting can also be performed by selectively increasing the light intensity of the appropriate light sources 149 or by any other suitable highlighting method. Fig. 21C is a schematic view illustrating the fused test image as seen by the subject undergoing the vertical phoria test illustrated in Figs. 21A and 21B. The exemplary test pattern 232A of Fig. 21A which is presented to the left eye of the subject 22 includes an image of a horizontal arrow 232C and the exemplary test pattern 232B of Fig. 21B which is presented to the right eye of the subject 22 includes an image of four ladders 232D and four images of labeling numerals 1,2,3,and 4 which are associated with the ladders. The fused test image 230 of Fig. 21C as seen by the subject 22 includes a fused test pattern 232 in which the arrow 232C is seen to be pointing at one of the ladders 232D. in the particular example of Fig. 21C, the arrow 232C is shown pointing at the ladder associated with the labeling numeral 3. However, different tested subjects having different degrees of vertical phoria will see the arrow 232C pointing at a different ladder of the four ladders 232D.

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The subject 22 can use th user int rface 8 to select the proper answer as disclosed hereinabove. In the ex mplary test image of Fig. 21 The answer to be chosen is the pattern 236 corresponding with the digit 2 labeling the ladder to which the arrow 232C is pointing test patt rn 232.

Fig. 22 is a schematic view illustrating an exemplary test image 240 as seen by one of the eyes of a subject in a vision accuity test using the optical testing unit of Fig. 8. The test image 240 includes a single test pattern 242 projected by the test pattern projection unit 150 of Fig. 9 and an answer pattern 244 projected by the answer display unit 140 of Fig. 9. The exemplary test pattern 242 of Fig. 22 shows the character C oriented such that its open sid is directed to the right side of the user 22. The answer pattern 244 includ s four patterns 245, 246, 247 and 248. Each of the four patterns 245, 246, 247 and 248 shows an arrowhead pointing in a different direction. During the test, Only one of the four patterns 245, 246, 247 and 248 is highlighted and the subject can use the user interface 8 to select the proper answer as disclosed hereinabove. In the exemplary test image of Fig. 22 the correct answer is the pattern 246 showing an arrowhead pointing to the right side of the user.

The vision tests

In accordance with a preferred embodiment of the present invention, the system 1 can administer seven different vision tests for self testing by the us r 22: a vision acuity test, a stereoscopic depth perception test, a lateral and vertical phoria test, a fusion test, a lateral field of view (FOV) test, a vision und r glare conditions test and a color vision test.

The vision acuity test can be performed for both eyes and for each eye individually. The vision acuity test can be performed for far, near and intermediate viewing distance and under a variety of contrast levels and illumination color.

It is noted that, in accordance with a preferred embodiment of the present invention, the system for automatic self-testing of vision can be adapted to performing other types of tests by suitably installing different types of slides in the optical testing unit 2 or by displaying other test images on the display 5 of the computer 4.

Reference is now made to Figs. 23A and 23B, which are a schematic flow diagram illustrating the control flow of vision testing p rformed by the system during automatic self-testing of vision by the user 22, in accordance with

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a preferred embodiment of the present invention. Th system begins by presenting an entry screen, the entry screen can also include instructions for self-identifying of the user 22 as disclosed hereinabove (not shown). Th entry screen gives the user 22 the choice to have a self-tutoring session (step 400). If the user 22 answers positively, the system presents a series of tutoring screens (step 404) and then presents a series of training screens (step 406), If the user 22 answers negatively, the system passes directly to step 406.

After the training step 406 is completed, the computer presents screens explaining the vision acuity test (step 408). The system prepares the optical testing unit for the vision acuity test and the user 22 performs the vision acuity test (step 410).

After the vision acuity test is completed, the system presents screens explaining the stereoscopic depth perception test (step 412). The system prepares the optical testing unit for the depth perception test and the user 22 performs the depth perception test (step 414).

After the stereoscopic depth perception test is completed, the computer presents screens explaining the lateral and vertical phoria test (step 416). The system prepares the optical testing unit for the lateral and vertical phoria test and the user 22 performs the lateral and vertical phoria test (step 418).

After the lateral and vertical phoria test is completed, the computer presents screens explaining the fusion test (step 420). The system prepares the optical testing unit for the fusion test and the user 22 performs the fusion test (step 422).

After the fusion test is completed, the computer presents screens explaining the FOV (step 424). The system prepares the optical testing unit for the FOV test and the user 22 performs the FOV test (step 426).

After the FOV test is completed, the computer presents screens explaining the vision under glare test (step 428). The system prepares the optical testing unit for the vision under glare test and the user 22 performs the vision under glare test (step 430).

After the vision under glare test is completed, the computer presents screens explaining the color vision test (step 432). The system prepares the optical testing unit for the color vision test and the user 22 performs the color vision test (step 434).

After the color vision test is completed th computer checks if the printing system has been disabled (step 436). If the printing system has been disabled,

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the computer goes to step 403. If the printing is not disabled, the system checks if th automatic printing is enabled (step 438). If th automatic printing is enabl d, the system automatically prints a test r port on the print r 3 (step 442) and goes to step 403. If the automatic printing is not enabled, the system presents a "print report ?" query screen (step 440). If the user 22 answers the query negatively, control is transferred to step 403. If the user 22 answers the query positively, control is transferred to step 442 for printing a report and then control is transferred to step 403 for presenting the opening screen.

After any of the vision tests the user can initiate an exit from the testing procedure. Upon a user's exit request, the system presents an exit qu ry screen (step 401). The user 22 can respond negatively to the query, in which case control is returned to the same point in the test from which the exit was made. If the user confirms the exit request, the system presents the opening screen (step 403).

It will be appreciated by those skilled in the art that there are many possible ways to implement the control flow of the vision testing main program of Figs. 23A and 23B, which are within the spirit and scope of the present invention. For example, While the order of vision tests in the non-limiting exemplary main program of Figs. 23A and 23B is shown to be fixed, many variations of the program are possible in which the program can be arranged to administer any combination of tests or training or tutoring included in the step 404 and the group of steps referenced 405 of Fig. 23A. The program can also enable a supervisor or system operator to select a specific number of tests to be administered to a subject in a specific order. Additionally the main program can also be constructed to automatically and dynamically change the number, type and sequence of presentation of the tests, training and tutoring for a specific subject based on previous test history of that subject which is stored in the system or to perform these changes based upon instructions from a superviser or one or more remote experts.

The vision acuity test

Reference is now made to Figs. 24 and 25, which are schematic flow diagrams illustrating the control flow of the vision acuity test, performed by the system for automatic self testing of vision, in accordance with a preferred embodiment of the pres nt invention. The system conducts the vision acuity

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test by presenting to the user 22 a single test pattern and an answer pattern. The available test patterns are divided into six sub-test groups. Each of the sub-test groups has a different pattern siz . **Table 1** hereinbelow indicates the different sub-test numbers with their corresponding vision acuity values.

The parameters of the vision acuity test are:

i is the number of the currently used sub-test.

Tc is the maximal amount of time allowed for responding to a displayed test pattern.

To is the maximal amount of time allowed for changing the answer for a displayed test pattern.

En is the maximal allowed number of answer changes for a displayed test pattern.

St is the sub-test group number selected for starting the vision acuity test.

Ed is the sub-test group number of the smallest size test pattern in the vision acuity test.

C(i) is the number of available test patterns within sub-test **i**.

N(i) is the number of test patterns to be presented for a sub-test **i**.

E(i) is the number of wrong answers constituting a failure for a sub-test **i**.

n is the current number of tests patterns displayed within the current sub-test.

x is the current accumulated number of failures within the current sub-test.

s is the current number of answer changes within the current sub-test.

Table 1.

Sub-test Number (i)	Corresponding Snellen's fraction
1	6/30
2	6/24
3	6/18
4	6/12
5	6/9
6	6/6

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A non-limiting example of th values of the parameters used in a preferred embodiment of th vision acuity test of the present invention is:

Tc = 20 seconds; **To** = 1 second; **En** =1; **St** = 3; **Ed** = 6; **C(i) = N(i) =** 4 (for **i** = 2,3,4,5,6); **E(i)** = 1 (for **i** =1, 2,3,4,5,6).

Turning to Fig. 24, the system starts the vision acuity test by setting **St** as the value of the parameter **i** (step 450). The system then performs sub-test **i** (step 452). The system checks if the result of sub-test **i** is a failure (step 454). If the result of sub-test **i** is a failure, the system decreases **i** by 1 (step 456) and checks if **i** equals zero (step 460). If **i** equals zero, the system records the result of the vision acuity test as a total failure (step 468) and transfers control to the stereoscopic depth perception test (step 476). If **i** does not equal zero, th system performs sub-test **i** (step 462). The system checks if the result of the sub-test **i** is a failure (step 464). If the result of the sub-test **i** is a failure, the system transfers control to step 456. If the result of the sub-test **i** is not a failure, the system records the value of **i** as the test result (step 466) and transfers control to step 476.

If the result of the sub-test **i** in step 454 is not a failure, the system increments the value of **i** by 1 (step 458). The system checks if **i** is larger than **Ed** (step 470). If **i** is not larger than **Ed**, the system transfers control to step 452. If **i** is larger than **Ed**, the system decrements **i** by 1 (step 472), records the value of **i** as the test result (step 474) and transfers control to th main program (step 476).

Turning to Fig. 25, when the system starts the sub-test **i** , the system sets the value of the parameters **s**, **x** and **n** to zero (step 478), sets **n** = **n** +1 (step 480) and displays a test pattern of the sub-group **i** which has not been displayed yet (step 482). This is done by randomly choosing a test pattern out of th group consisting of all the test patterns of sub-group **i** which were not displayed yet within the current sub-test **i**.

The system checks if an answer is received within a time period of **Tc** seconds starting at the time of presentation of the selected test pattern (step 484). If an answer is not received within **Tc** seconds, the system sets **x** = **x**+1 (step 494) and checks if **x** = **E(i)** (step 496). If **x** = **E(i)** , the system records a

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sub-test failure (step 498) and returns control to the main program (step 504). If **x** is not equal to **E(i)**, the system transf rs control to step 480.

If an answer is received within a time period of **Tc** seconds starting at the time of presentation of the selected test pattern, the system checks if **s = En** (step 486).

If **s = En**, the system checks if the accepted answer is correct (step 492). If the accepted answer is not correct, the system transfers control to step 494. If the accepted answer is correct, the system checks if **n = N(i)** (step 500). If **n = N(i)**, the system records a sub-test success (step 502) and returns control to the main program (step 504). If **n** is not equal to **N(i)**, the system transfers control to step 480.

Turning back to step 486, if **s** is not equal to **En**, the system checks if a change of answer has been received within a time period of **To** seconds starting at the time of presentation of the test image (step 488). If a change of answer was received within **To** seconds, the system increments the value of **s** by 1 (step 490) and transfers control to step 484. If a change of answer was not received within **To** seconds, the system transfers control to step 492.

It is noted that, while in the embodiment of the vision acuity t st illustrated in Figs. 24 and 25 the system starts from a fixed sub- test I, wherein i **= St** , in accordance with another preferred embodiment of the present invention when the system identifies a user the system checks the past test results of the user which are stored in a database to determine the proper sub-test number for starting the testing. For example, if the system finds in th database that the identified user previously failed in the sub-test number 2 (Table 1), the system will start the test from sub-test number 1(Table 1). This may shorten the duration of the test by reducing the number of presented t st images. Thus, the system can adapt the number and type of test images to the test history of the user.

It if further noted that the method of adapting of the test procedure to the test history of the user is not limited to the vision acuity test and that the system can be configured to use it in other tests such as the vision acuity under glare condition test , or any other vision test to which such a method may be used.

The stereoscopic depth perception test

The flow control diagrams of the stereoscopic depth perception test are similar to the flow control diagrams of the vision acuity test (Figs. 24 and 25).

The test patterns used in the stereoscopic depth perception test are different from the vision acuity test.

A non-limiting example of the values of the parameters used in a preferred embodiment of the stereoscopic depth perception test of the present invention is:

Tc = 20 seconds; **To** = 1 second; **En** =3; **St** = 3; **Ed** = 5; **C(i)** = **N(i)** = 4 (for **i** = 2,3,4,5); **E(i)** = 3 (for **i** =1,2,3,4,5,6).

The lateral and vertical phoria test

Reference is now made to Figs. 26A and 26B, which are schematic flow diagrams illustrating the control flow of the lateral and vertical phoria test, performed by the system for automatic self testing of vision, in accordance with a preferred embodiment of the present invention.

The system starts by displaying a vertical test pattern (step 510). The system sets i=0 (step 512). The system checks if an answer was received within a period of T_A seconds (step 514). If no answer was received within a period of T_A seconds, the system records "No Answer" (step 516) and transfers control to step 528. If an answer was received within a period of T_A seconds, the system accepts the answer (step 518). The system then checks if i = 3 (step 520). If i equals 3, the system transfer control to step 526. If If i does not equal 3, the system checks if a change of answer was received within T_B seconds (step 522). If a change of answer was received within T_B seconds, the system sets i = i + 1 (step 524) and transfers control to step 514. If a change of answer was not received within T_B seconds, the system records the answer (step 526), displays a horizontal test pattern (step 528) and sets i=0 (step 530).

The system checks if an answer was received within a period of T_A seconds (step 532). If no answer was received within a period of T_A seconds, the system records "No Answer" (step 534) and transfers control to the fusion test explanation (step 546). If an answer was received within a period of T_A seconds, the system accepts the answer (step 536). The system then checks if i = 3 (step 538). If i equals 3, the system records the answer (step 544) and transfer control to step 546. If i does not equal 3, the system checks if a change of answer was received within T_B seconds (step 540). If a change of answer was received within T_B seconds, the system sets i = i + 1 (step 542)

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and transfers control to step 532. If a change of answer was not received within T_B seconds, the system records the answer (step 544) and transfers control to the main program (step 546).

A non-limiting example of the values of the parameters used in a preferred embodiment of the lateral and vertical phoria test of the present invention is:

T_A = 20 seconds; T_B = 1 second;

The fusion test

Reference is now made to Fig. 27, which is a schematic flow diagram illustrating the control flow of the fusion test, performed by the system for automatic self testing of vision, in accordance with a preferred embodiment of the present invention.

The system starts by displaying a fusion test pattern (step 550). The system sets i=0 (step 552). The system checks if an answer was received within a period of T_R seconds (step 554). If no answer was received within a period of T_A seconds, the system records "No Answer" (step 556) and transfers control to step 568. If an answer was received within a period of T_R seconds, the system accepts the answer (step 558). The system then checks if i = 3 (step 560). If i equals 3, the system transfer control to step 566. If i does not equal 3, the system checks if a change of answer was received within T_D seconds (step 562). If a change of answer was received within T_D seconds, the system sets i = i + 1 (step 564) and transfers control to step 554. If a change of answer was not received within T_D seconds, the system records the answer (step 566) and transfers control to the main program (step 568).

A non-limiting example of the values of the parameters used in a preferred embodiment of the fusion test of the present invention is:

T_R = 20 seconds; T_D = 1 second;

The FOV test

Reference is now made to Fig. 28, which is a schematic flow diagram illustrating the control flow of the FOV test, performed by the system for automatic self testing of vision, in accordance with a preferred embodiment of the present invention.

The system starts by setting up a group S including the eight numbers 0, 1, 2, 3, 4, 5, 6 and 7, representing the light sources L0, L1, L2, L3, L4, L5, L6

and L7 of Fig. 6, respectively (step 570). The system chooses uniformly at random a numb r i from the group S and remov s the chosen number i from the group S such that S = S\ { i } (step 572). The system activates the light source Li (which is represented by the number i) for a time interval of T_K seconds (step 574). The system checks if an answer was received within T_H seconds. If an answer was not received within T_H seconds, the system transfers control to step 580. If an answer was received within T_H seconds, the system records the answer (step 578) and checks if S is an empty group containing no members (step 580). If S is not an empty group and still contains members, the system transfers control to step 572.). If S is an empty group and contains no members which happens when all the light sources Li have already been turned on, the system checks the whether all the light sources Li have been seen by the user (step 582). If all the light sources Li have been seen by the user, the system records the test result as "success" (step 584) and transfers control to step 592. If not all the light sources Li have been seen by the user, the system checks whether the light sources L3 or L4 were not seen by the user (step 586). If the light sources L3 or L4 were not seen by the user, the system records the test result as "failure" (step 588) and transfers control to step 592. If the light sources L3 or L4 were seen by the user, the system records the test result as "unreliable" (step 590) and transfers control to main program (step 592).

A non-limiting example of the values of the parameters used in a preferred embodiment of the FOV test of the present invention is:

T_K = 1.75 seconds; T_H = 4 second;

The vision under glare test

The vision under glare test is performed similarly to the vision acuity test of Figs. 24 and 25, except that both glare illumination units 100 and 120 are activated to provide suitable glare conditions. All The parameter values for th test are identical to the parameters disclosed for the vision acuity test of Figs. 24 and 25 hereinabove.

The color vision test

Reference is now made to Fig.29, which is a schematic flow diagram illustrating the control flow of the color vision test, performed by the system for automatic self testing of vision, in accordance with a preferred embodim nt of the present inv ntion.

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The system starts by setting i = 1 and j = 0 (step 550), wherein i is the number repr senting a color vision test image select d from a group S = {1,2,3,4,5,6} of six different color test image numbers. The system displays the color test image i on the display 5 of the computer 4 (step 602). The system checks whether an answer is received within T_E seconds (step 604). If an answer is not received within T_E seconds, the system records "no answer" (step 616) and transfers control to step 618. If an answer is received within T_E seconds, the system accepts the answer (step 606) and checks whether j is equal to 3. If j is equal to 3, the system transfers control to step 614. If j is not equal to 3, the system checks whether a change of answer is received within T_F seconds. If a change of answer is received within T_F seconds, the system increments the value of the parameter j by one (step 612) and returns control to step 604. If a change of answer is not received within T_F seconds, the system records the answer (step 614) and checks whether i is equal to 6 (step 618). If i is not equal to 6, the system increments the value of the parameter i by one sets the value of the parameter j to zero (step 620) and transfers control to step 604. If i is equal to 6, the system transfers control to the opening screen of step 403 of Fig. 23A.

A non-limiting example of the values of the parameters used in a preferred embodiment of the color vision test of the present invention is:

T_E = 20 seconds; T_F = 1second.

Reference is now made to Fig. 30 which is a pictorial illustration of an optical testing unit useful in the systems for automatic self testing of vision and having a movable head-rest for adjusting the line of sight of a user w aring bifoca, multifocal or continuous focus eyeglasses, in accordance with another preferred embodiment of the present invention.

The optical testing unit 650 includes a housing 651 and a movable head-rest 652 rotatably attached to the housing 651. A user 654 wearing bifocal, multifocal or continuous focus eyeglasses 653 puts his head in contact with the head-rest 652 and can adjust the line of sight during changes in the viewing conditions of the test by pivotally rotating the head-rest 652 in the directions indicated by the dashed arrow 655. The other parts of the testing optical unit 650 may be similar to those of the optical testing unit 2.

It is noted that, while the non-limiting examples of optical testing units 2 and 650 project test images by using apparatus for illuminating suitable slide

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ass mblies, other methods of constructing optical testing units are possible which ar included within the scope and spirit of the present invention.

Reference is now made to Fig. 31 which is a schematic top view of an optical testing unit, usful in the system 1 of Figs. 4, and having a display unit, in accordance with yet another preferred embodiment of the present invention. The optical testing unit 670 includes a display unit 675 attached to a housing 676. The display unit 675 projects test images to the left or right eye of the user 22 or to both eyes of the user 22. Each of the test images projected onto the eyes of the user 22 has an answer pattern and a test pattern as described in detail for the optical test unit 2 hereinabove. The display unit 675 thus obviates the need for the test pattern projection unit 150 and the answer display unit 140 of Fig. 9. The optical testing unit 670 further includes an eye enclosure 28, a filter 59 a near/ intermediate field optical assembly 60, a line of sight deflecting unit 80 and two glare illumination units 100 and 120 which are constructed and operate as disclosed in detail for the optical testing unit 2 hereinabove. The optical testing unit 670 also includes a control unit 677 for controlling the operation of the display unit 670 and the other parts of the optical testing unit 670. The display unit can be any active or passive display device that can display a test image. For example the display unit may include a passive liquid crystal display (LCD) unit and a suitable light source, an electroluminescent display, a plasma display, a CRT display or any other suitable type of display.

An advantage of the optical testing unit is that it can display any numb r of preselected test images by downloading image data from the computer 4 or from any other data source such as a remote computer communicating with the optical testing unit 670 either directly or through the computer 4. Thus, the number of testing images that can be displayed by the optical testing unit 670 is practically unlimited.

While the invention has been described with respect to a limited numb r of embodiments, it will be appreciated that many variations, modifications and other applications of the invention may be made.

It will be appreciated by persons skilled in the art that the present invention is not limited to what has been particularly shown and described hereinabove. Rather the scope of the present invention is defined only by the claims which follow.

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CLAIMS

1. A system for automatically managing summoning to a session including at least one of self-training, self-testing and self tutoring at least one subject, the system comprising:

a summoning apparatus for summoning at least one subject to said session;

apparatus for performing said session; and

a control apparatus for controlling said summoning and said session.

2. The system according to claim 1 further comprising identification means for identifying each said at least one subject at least before said session.

3. The system according to claim 1 wherein said control apparatus comprises:

a processor; and

a data storage unit connected to said processor for storing identification data of said at least one subject .

4. The system according to claim 3 wherein said data also includes results of previous session and wherein said control apparatus further comprising means for comparing said results of previous sessions with results of a current session.

5. The system according to claim 1 wherein said summoning apparatus, said apparatus for performing said session and said control apparatus are connected in a Local Area Network or via a Wide Area Network.

6. The system according to claim 5 wherein said summoning apparatus comprises an electronic mail server for transmitting e-mail summoning messages to said at least one subject.

7. The system according to claim 5 wherein said summoning apparatus comprises a telephone for transmitting telephone summoning messages to said at least one subject.

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8. The system according to claim 5 wherein said summoning apparatus compris s a printer for printing summoning messages to said at l ast one subject.

9. The system according to claim 5 wherein said Wide Area Network is the internet.

10. The system according to claim 2 wherein said identification means include any combination of an electromagnetic card reader, a voice recognition devic , a video camera, a finger print analyzer, an iris analyzer, a face analyzer and a key-pad for keying a password.

11. The system according to claim 10 wherein at least one of said identification means is operative during said session to verify the identity of said subject during said session:

12. The system according to claim 1 wherein said apparatus for performing said session comprises a subject interface and means for performing said self-training, self-testing and self-tutoring.

13. The system according to claim 12 wherein said self-testing means include means for performing a medical test.

14. The system according to claim 12 wherein said self-tutoring means includ means for performing a tutorial for qualifying said subject in accordance with qualification regulations.

15. The system according to claim 1 also operative to automatically analyzing said results of said self-testing.

16. The system according to claim 15 wherein said system further comprising means for analyzing said results remote of said apparatus for performing said session.

17. The system according to claim 16 wherein said means for analyzing include a human interface for allowing an expert to receive said results and to input data related thereto.

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18. The system according to claim 9 wherein said apparatus for performing said session is remot from said summoning apparatus and control apparatus wh reby said subjects perform said session in a remote location.

19. The system according to claim 1 also including a human supervisor interface for allowing said supervisor to change parameters in said control apparatus.

20. The system according to claim 17 wherein said control apparatus is operative to determine the next session and indicate same to said summoning apparatus.

21. The system according to claim 12 wherein said self-training means include means for training said at least one subject to perform a test.

22. A system for automatic self-testing of vision, the system comprising:

an optical testing unit for testing vision of a user; and

a computer connected to said optical testing unit for controlling said optical testing unit, receiving data from said optical testing unit and for processing said data, said computer including means for receiving input from said user and means for providing automatic tutoring and training to said user.

23. The system according to claim 22 further comprising means for identifying said user.

24. The system according to claim 23 wherein said means for identifying is selected from the group consisting of an electromagnetic card reader, a voice recognition device, a video camera, a finger print analyzer, an iris analyzer, a retinal pattern analyzer, a face analyzer , a keyboard or keypad for keying a password, a pointing device for selecting an item from a list and any combination thereof.

25. The system according to claim 22 wherein said means for receiving input from said user is selected from the group consisting of a keyboard, a pointing device, a touch sensitive screen, a light-pen, a microphone connected to a sound card, or any combination thereof and wherein said means for providing automatic tutoring and training to said user is s lected from th group consisting

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of a visual display unit, a loudspeaker connected to a sound card or any combination thereof.

26. The system according to claim 22 wherein said optical testing unit comprises:

a light occluding housing;

a test image projection unit attached to said housing for projecting a test image onto at least one eye of said user, said test image projection unit including:

a test pattern projection unit for projecting a single test pattern selected out of a plurality of available single test patterns onto at least one eye of said user; and

an answer pattern projection unit for projecting a multiple-choic answer pattern onto said at least one eye of said user;

an optical assembly, attached to said housing, for providing a viewing station from which said test image is viewed by said user; and

a controller unit connected to said test image projection unit, said viewing means and said computer for controlling the operation of said test image projection unit and said optical assembly, and for bidirectionally communicating with said computer.

27. The system according to claim 26 wherein said test pattern projection unit comprises:

a projector housing having an opening therein, said projector housing being movable along a direction orthogonal to the viewing axis of said user through said optical assembly;

a slide rotating assembly rotatably attached within said projector housing, said slide rotating assembly including a plurality of slide assemblies; and

a slide illuminating unit positioned within said slide rotating assembly for illuminating a selected one of said plurality of slide assemblies positioned in front of said opening,

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wh r in each of said slide assemblies comprises at least two pairs of test slides and wherein ach of said pairs of test slides can be viewed by said user by moving said projector housing of said test pattern projection unit to a predetermined position.

28. The system according to claim 26 wherein said answer pattern projection unit comprises:

a slide holder for holding an answer pattern slide;

an illumination unit for illuminating said answer pattern slide; and

a reflector for projecting an image of said answer pattern slide onto at least one eye of said user.

29. The system according to claim 26 wherein said optical assembly comprises:

means for adjusting said test image for testing far field vision, near field vision and intermediate field vision; and

means for deflecting the line of sight for adapting said optical device for use by a user wearing bifocal, multifocal or progressive focus eye glasses.

30. The system according to claim 26 wherein said optical testing unit furth r comprises an eye enclosure having a plurality of light sources arranged horizontally within said eye enclosure for testing the horizontal field of view (FOV) of said user.

31. The system according to claim 30 wherein said eye enclosure further includes a sensor for sensing the presence of the head of said user within said eye enclosure.

32. The system according to claim 31 wherein said sensor comprises:

an emitter attached to a first side of said eye enclosure for emitting a beam of radiation; and

a detector attached to a second side of said eye enclosure for detecting said beam of radiation.

wh rein said beam of radiation is sel cted from the group consisting of a visibl light beam, an infra -red light beam and an acoustic radiation beam.

33. The system according to claim 26 wherein said optical testing unit further includes at least one glare illumination unit for providing illumination for visual testing under glare conditions.

34. The system according to claim 33 wherein said at least one glare unit can be rotated so as to minimize the reflection of stray light within said optical testing unit.

35. The system according to claim 29 wherein said means for deflecting the line of sight comprise:

a movable prism for deflecting said line of sight; and

a motor for inserting said prism into the optical axis of said optical assembly and for removing said prism from the optical axis of said optical assembly.

36. The system according to claim 29 wherein said means for deflecting th line of sight comprises:

a pair of non-parallel mirrors for deflecting said line of sight; and

a motor for inserting said pair of non-parallel mirrors into the optical axis of said optical assembly and for removing said pair of non-parallel mirrors from the optical axis of said optical assembly.

37. The system according to claim 22 further including means for storing said test result data.

38. The system according to claim 22 wherein said optical testing unit comprises:

a light occluding housing;

means for projecting a test image onto at least one eye of said user; and

means for providing a viewing station from which said test image is viewed by said user.

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39. The system according to claim 38 wherein said single test image includes a single test pattern and an answer pattern.

40. The system according to claim 39 wherein said answer pattern is a multiple choice answer pattern.

41. The system according to claim 38 wherein said means for projecting a test image is a display unit.

42. The system according to claim 41 wherein said display unit is selected from the group consisting of a cathode ray tube (CRT) display, an electro-luminescent display, a plasma display and a liquid crystal display (LCD) device coupled to a light source.

43. The system according to claim 29 wherein said means for deflecting the line of sight include a movable head-rest pivotally attached to said housing for enabling a user wearing bifocal, multifocal or progressive focus eye glasses to change his line of site.

44. A system for automatic self-testing of vision by a user, the system comprising:

means for providing said user with automatic tutoring and training in the performing of said self testing; and

means for automatically administering at least one vision test to said user and for storing the results of said at least one vision test ;

45. The system according to claim 44 further including means for identifying said user.

46. The system according to claim 45 wherein said means for identifying includes any combination of an electromagnetic card reader, a voice recognition device, a video camera, a finger print analyzer, an iris analyzer, a retinal pattern analyzer, a face analyzer and a keypad for keying a password.

47. A method for automatic self-testing of vision by a system for automatic self testing of vision, the system comprising an optical testing unit and a computer connected to said optical testing unit for controlling said optical testing unit, receiving data from said optical testing unit and for processing said data, said

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computer including means for receiving input from said user and means for providing automatic tutoring and training to said user, the method comprising the steps of:

providing said user with self-tutoring and self-training for performing said self-testing; and

automatically administering at least one vision test to said user.

48. The method according to claim 47 further including the step of storing the results of said at least one visual test in a database.

49. The method according to claim 47 further including the step of identifying said user prior to performing the steps of providing and automatically administering.

50. The method according to claim 49 wherein said step of identifying is performed by means for identifying said user, wherein said means of identifying is selected from the group consisting of an electromagnetic card reader, a voice recognition device, a video camera, a finger print analyzer, an iris analyzer, a retinal pattern analyzer, a face analyzer , a keyboard or keypad for keying a password, a pointing device for selecting an item from a list and any combination thereof.

51. The method according to claim 47 further including the step of providing a report including the results of said at least one vision test.

52. The method according to claim 51 wherein said report is selected from the group consisting of a hard-copy report, a report displayed on a display, a report communicated from said computer to another local or remote computer through a communication link, a report stored on suitable removable storage media and any combination thereof.

53. The method according to claim 47 wherein said at least one visual test is selected from the group consisting of a vision acuity test, a lateral and vertical phoria test, a stereoscopic depth perception test, a visual fusion test, a horizontal field of view (FOV) test, a color vision test and a vision acuity under glare conditions test.

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54. The method according to claim 53 wherein said vision acuity test and said vision acuity under glare conditions test can be selectably administered to the right eye, the left eye or to both eyes.

55. The method according to claim 47 wherein said step of automatically administering comprises the steps of:

presenting at least one eye of said user with visual test images, each of said visual test images comprising a single test pattern and a multiple-choice answer pattern;

receiving answers selected by said user through said means for receiving input during said at least one visual test; and

analyzing said answers to determine the test result of said at least one visual test.

56. The method according to claim 55 wherein said visual images are randomly or pseudo-randomly selected from a predetermined group of visual images for preventing prediction of said visual images by said user.

57. The method according to claim 55 wherein the number and type of said test images presented to said user is determined by the test history of said user for reducing the test duration.

58. An optical testing unit, connectable to a computer for administering automatic tutoring, training and self- testing to user, the optical testing unit comprising:

a light occluding housing;

a test image projection unit attached to said housing for projecting a test image onto at least one eye of said user;

an optical assembly, attached to said housing, for providing a viewing station from which said test image is viewed by said user; and

a controller unit connected to said test image projection unit, said viewing means and said computer for controlling the operation of said test image

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projection unit and said optical ass mbly, and for communicating with said computer.

59. The optical testing unit according to claim 58 wh rein said test image projection unit comprises:

a test pattern projection unit for projecting a single test pattern selected out of a plurality of available single test patterns onto at least one eye of said user; and

an answer pattern projection unit for projecting a multiple-choice answer pattern onto said at least one eye of said user.

60. The optical testing unit according to claim 58 wherein said test patt rn projection unit comprises:

a projector housing having an opening therein, said projector housing being movable along a direction orthogonal to the viewing axis of said user through said optical assembly;

a slide rotating assembly rotatably attached within said projector housing, said slide rotating assembly comprising a plurality of slide assemblies; and

a slide illuminating unit connected to said projector housing and positioned within said slide rotating assembly for illuminating a selected one of said plurality of slide assemblies positioned in front of said opening,

wherein each of said slide assemblies comprises at least two pairs of test slides and wherein each of said pairs of test slides can be viewed by said user by moving said projector housing of said test pattern projection unit to a predetermined position.

61. The optical testing unit according to claim 58 wherein said answer pattern projection unit comprises:

a slide holder for holding an answer pattern slide;

an illumination unit for illuminating said answer pattern slide; and

a reflector for projecting an image of said answer pattern slide onto at least one eye of said user.

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62. The optical testing unit according to claim 58 wherein said optical assembly comprises:

means for adjusting said test image for testing far field vision, near field vision and intermediate field vision; and

means for deflecting the line of sight for adapting said optical device for use by a user wearing bifocal, multifocal or progressive focus eye glasses.

63. The optical testing unit according to claim 58 wherein said optical testing unit further comprises an eye enclosure having a plurality of light sources arranged horizontally within said eye enclosure for testing the horizontal field of view (FOV) of said user.

64. The optical testing unit according to claim 63 wherein said eye enclosure further includes a sensor for sensing the presence of the head of said user within said eye enclosure.

65. The optical testing unit according to claim 64 wherein said sensor comprises:

an emitter attached to a first side of said eye enclosure for emitting a beam of radiation; and

a detector attached to a second side of said eye enclosure for detecting said beam of radiation,

wherein said beam of radiation is selected from the group consisting of a visible light beam, an infra -red light beam and an acoustic radiation beam.

66. The optical testing unit according to claim 60 wherein said optical testing unit further includes at least one glare illumination unit for providing illumination for visual testing under glare conditions.

67. The optical testing unit according to claim 66 wherein said at least one glare illumination unit can be rotated so as to minimize the reflection of stray light within said optical testing unit.

68. The optical testing unit according to claim 62 wherein said means for deflecting the line of sight comprises:

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a movable prism for deflecting said line of sight; and

a motor for inserting said prism into the optical axis of said optical assembly and for removing said prism from the optical axis of said optical assembly.

69. The optical testing unit according to claim 62 wherein said means for deflecting the line of sight comprises:

a pair of non-parallel mirrors for deflecting said line of sight; and

a motor for inserting said pair of non-parallel mirrors into the optical axis of said optical assembly and for removing said pair of non-parallel mirrors from the optical axis of said optical assembly.

70. The optical testing unit according to claim 62 wherein said means for deflecting the line of sight include a movable head-rest pivotally attached to said housing for enabling a user wearing to change his line of site.

71. A system for automatic self-testing of vision, the system comprising:

an optical testing unit for testing vision of a user, said optical testing unit being capable of projecting a test image onto at least one eye of said user, said test image being selected out of a plurality of test images, said test image including a test pattern and a multiple-choice answer pattern; and

a computer connected to said optical testing unit for controlling said optical testing unit, receiving data from said optical testing unit and input from said user and for processing and storing said data and said input , said computer including means for receiving said input from said user and means for providing automatic tutoring and training to said user.

72. The system according to claim 71 wherein the order of presentation of said test images is randomized or pseudo-randomized by said system.

73. The system according to claim 71 further including means for identifying said user.

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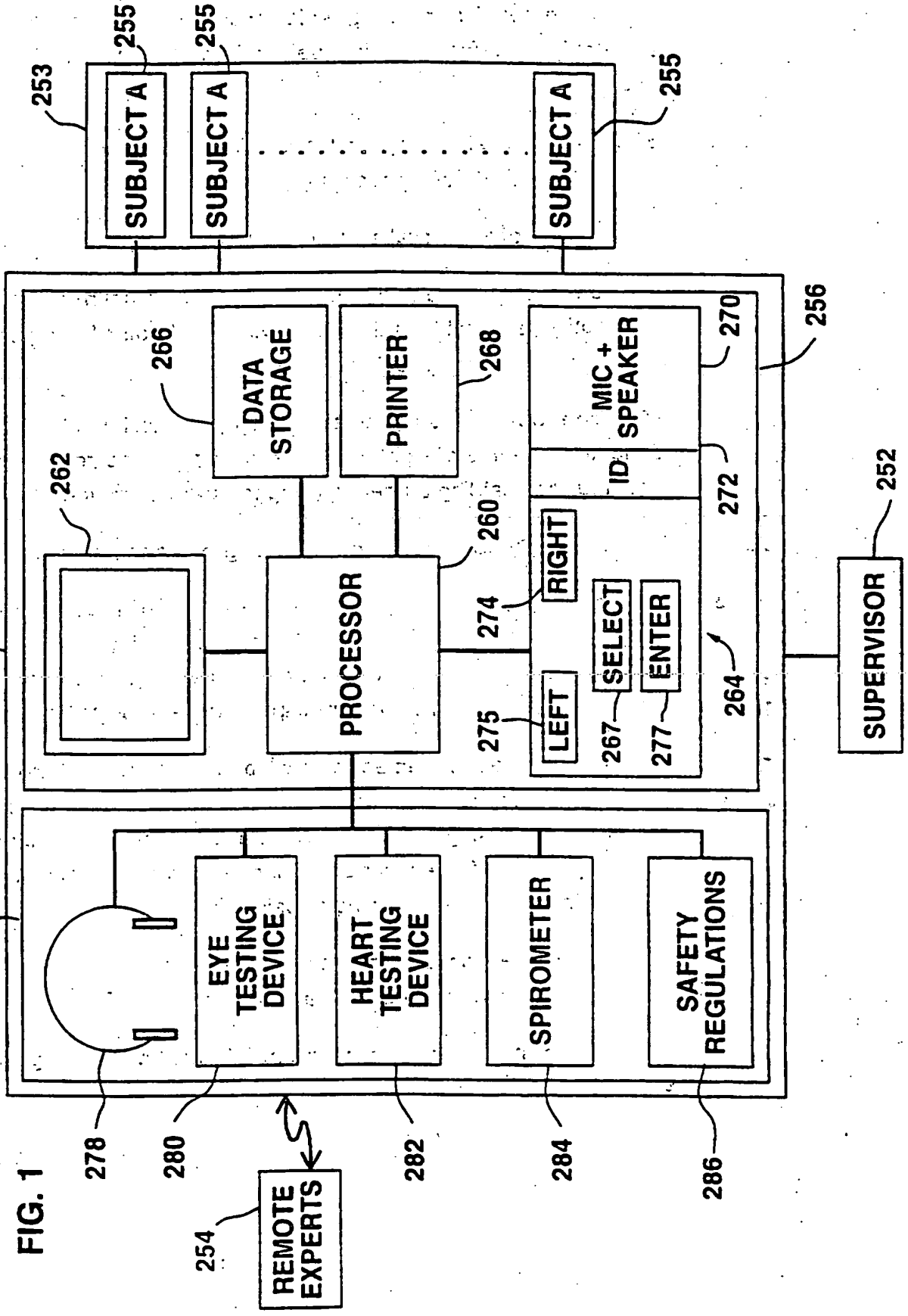

FIG. 1

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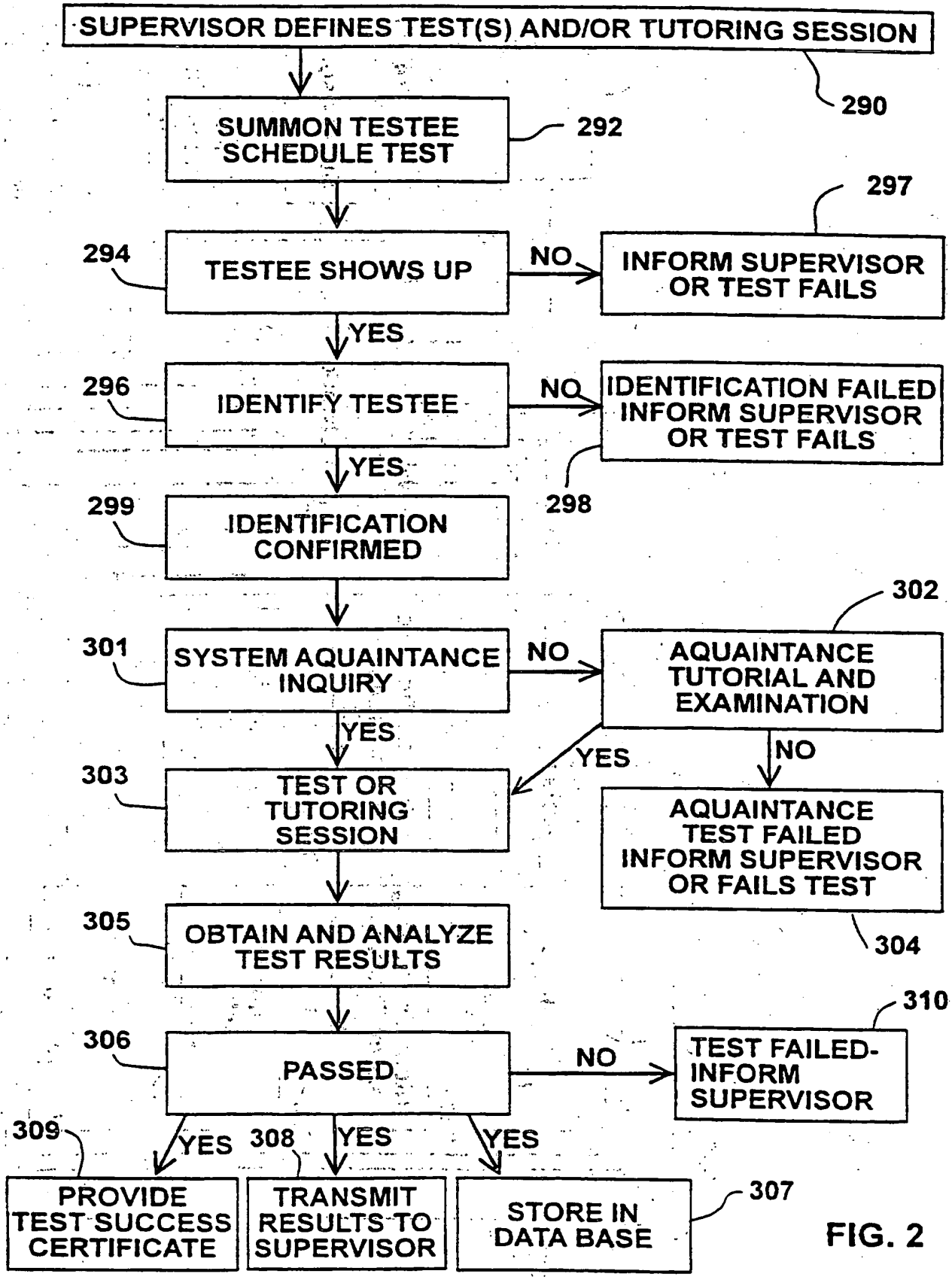

FIG. 2

BNSDOCID: <WO___9802083A2_I_>

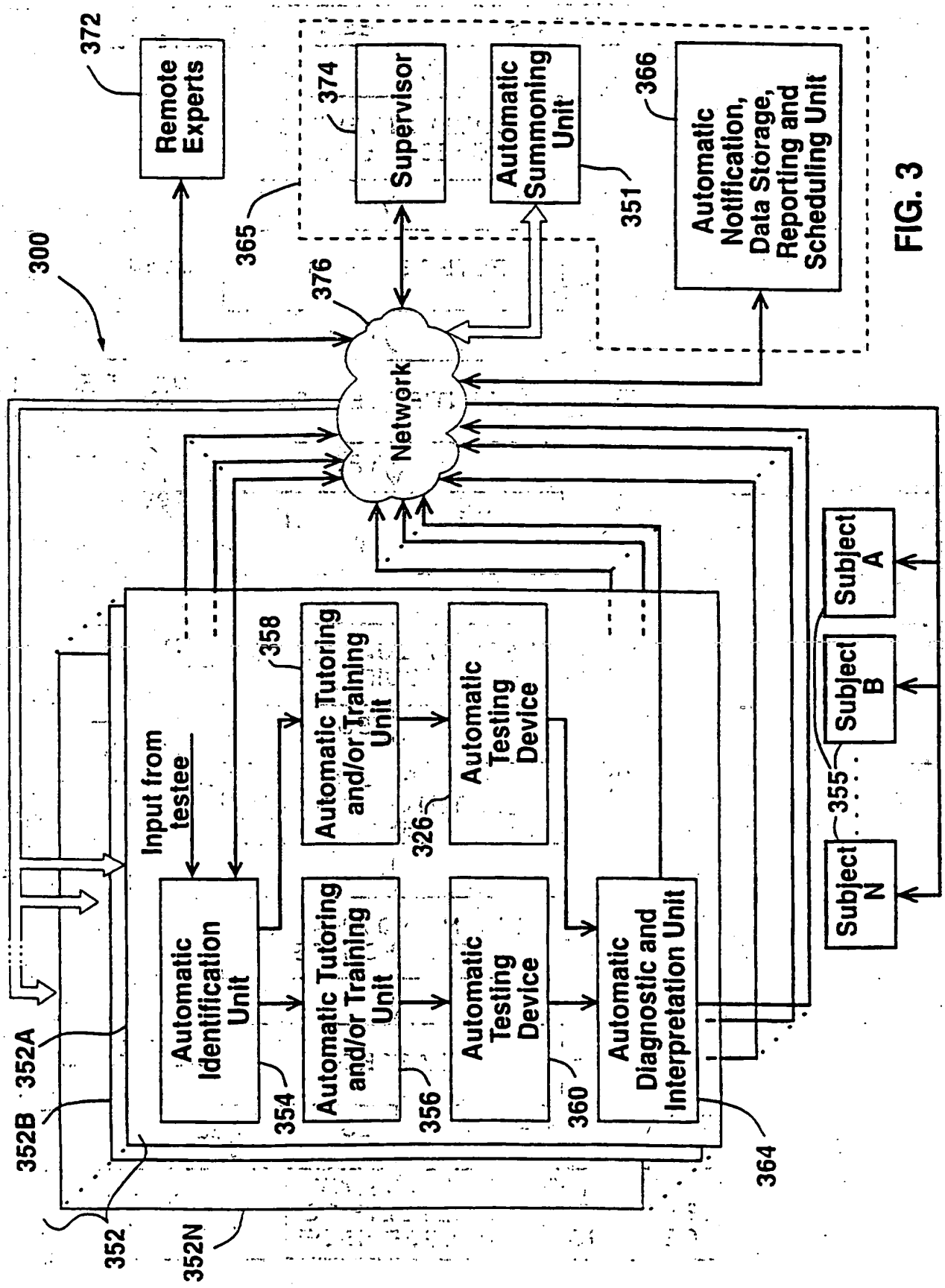

FIG. 3

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FIG. 4A

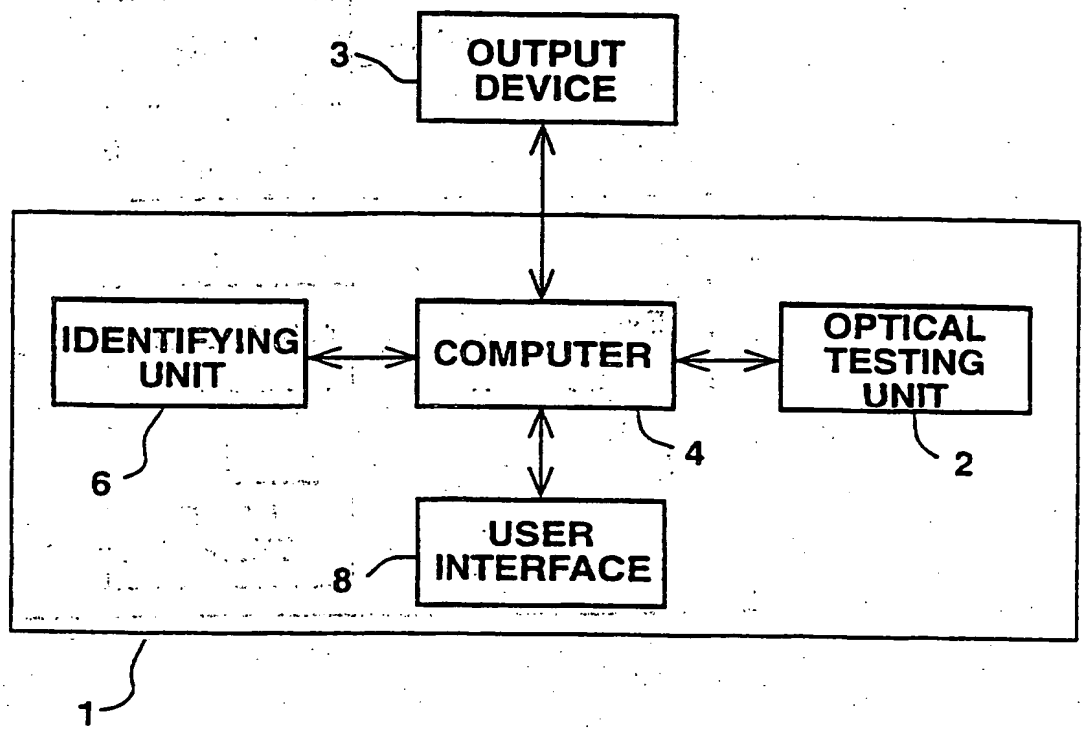

FIG. 4B

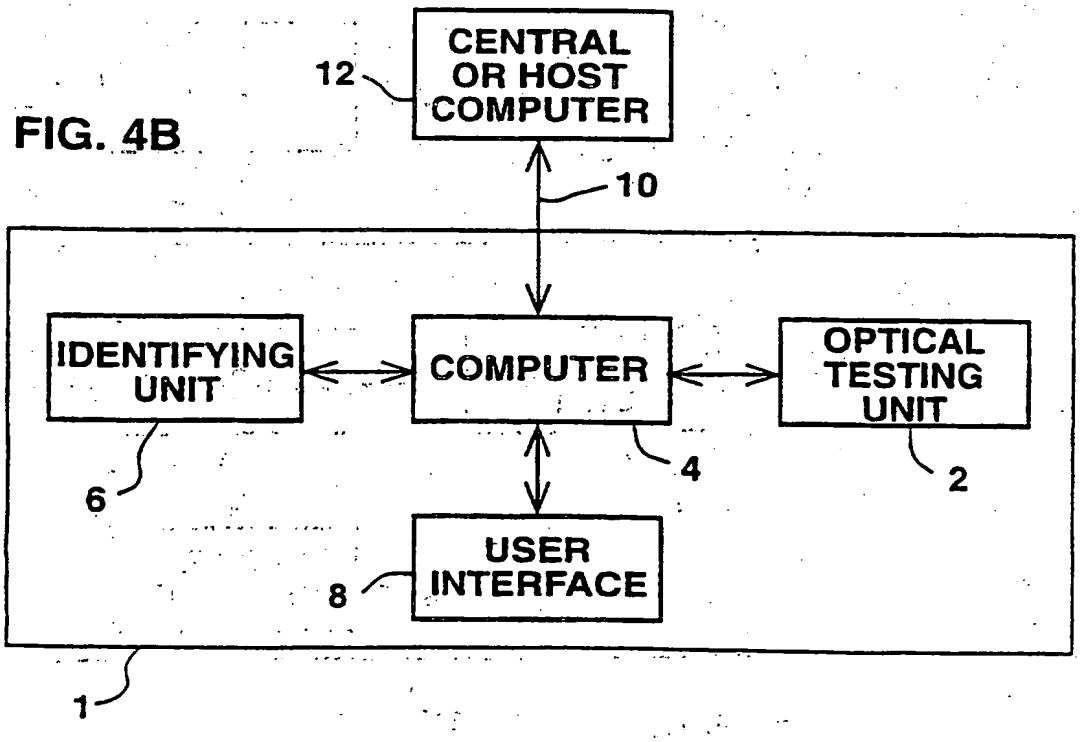

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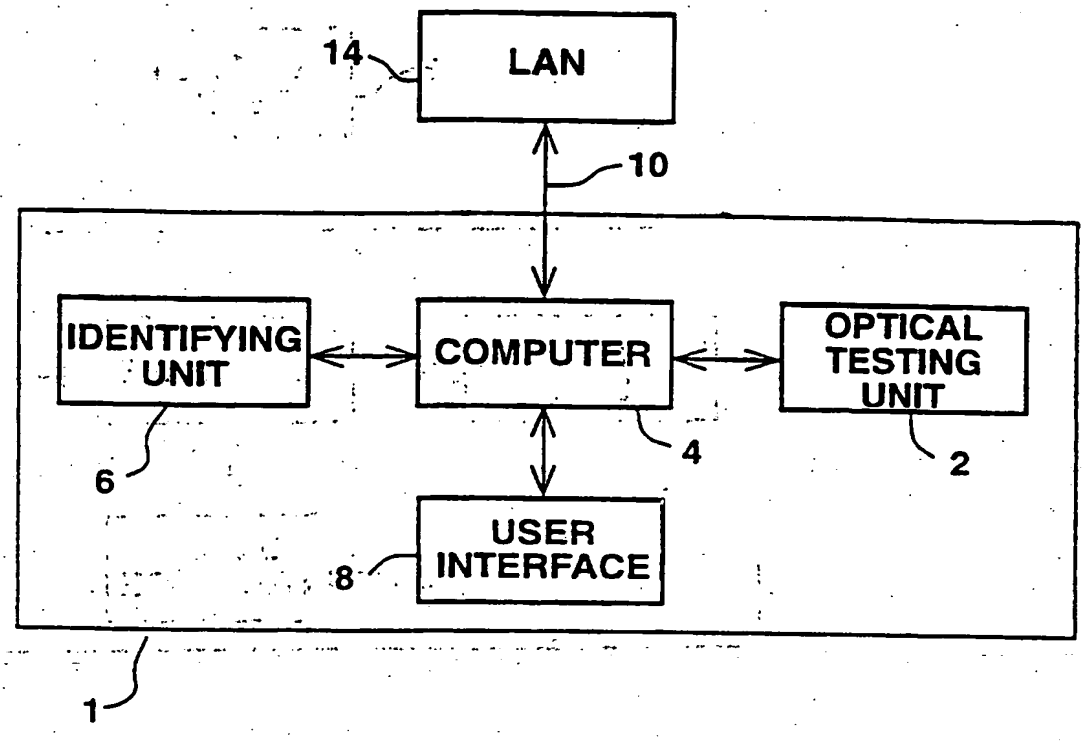
FIG. 4C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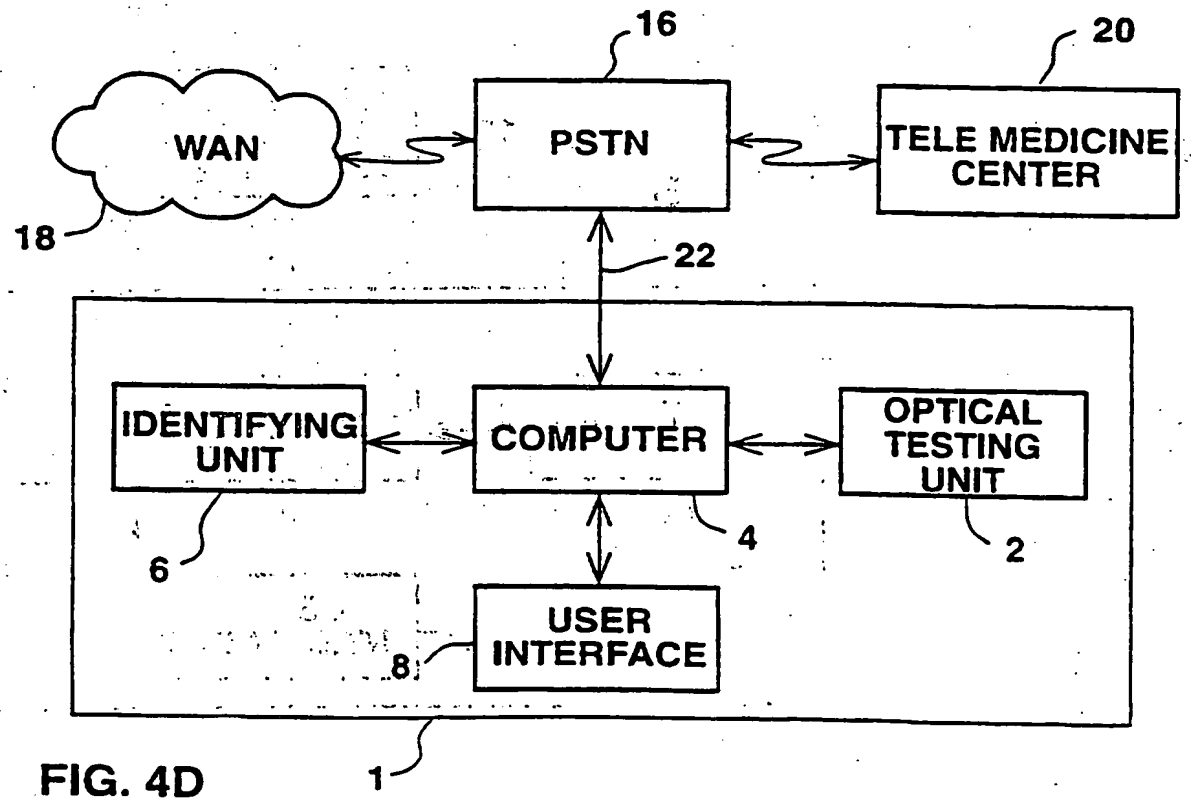
LAN
10
IDENTIFYING UNIT
COMPUTER
OPTICAL TESTING UNIT
6
4
2
USER INTERFACE
8
1


16
20
WAN
PSTN
TELE MEDICINE CENTER
18
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IDENTIFYING UNIT
COMPUTER
OPTICAL TESTING UNIT
6
4
2
USER INTERFACE
8
1

FIG. 4D

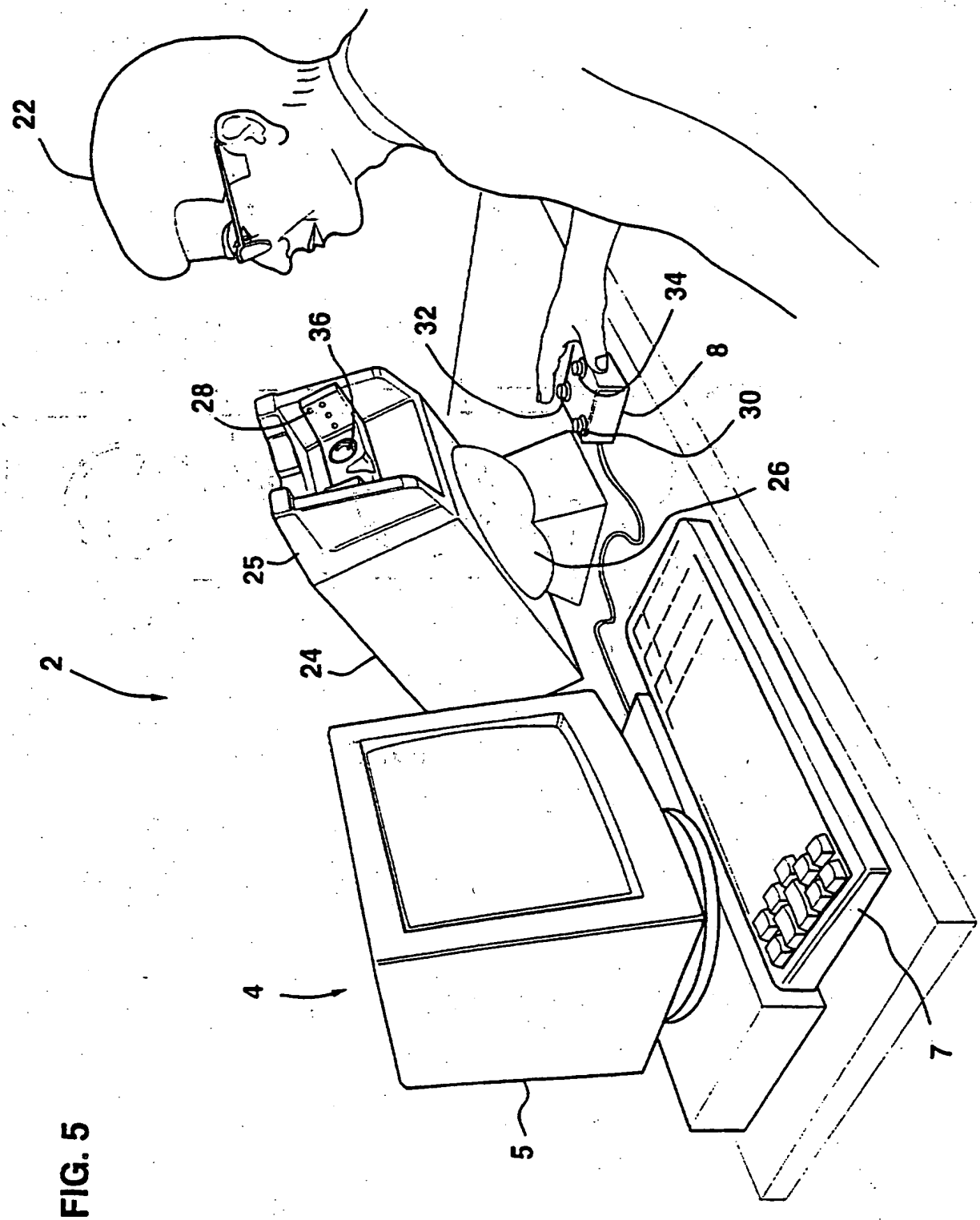

FIG. 5

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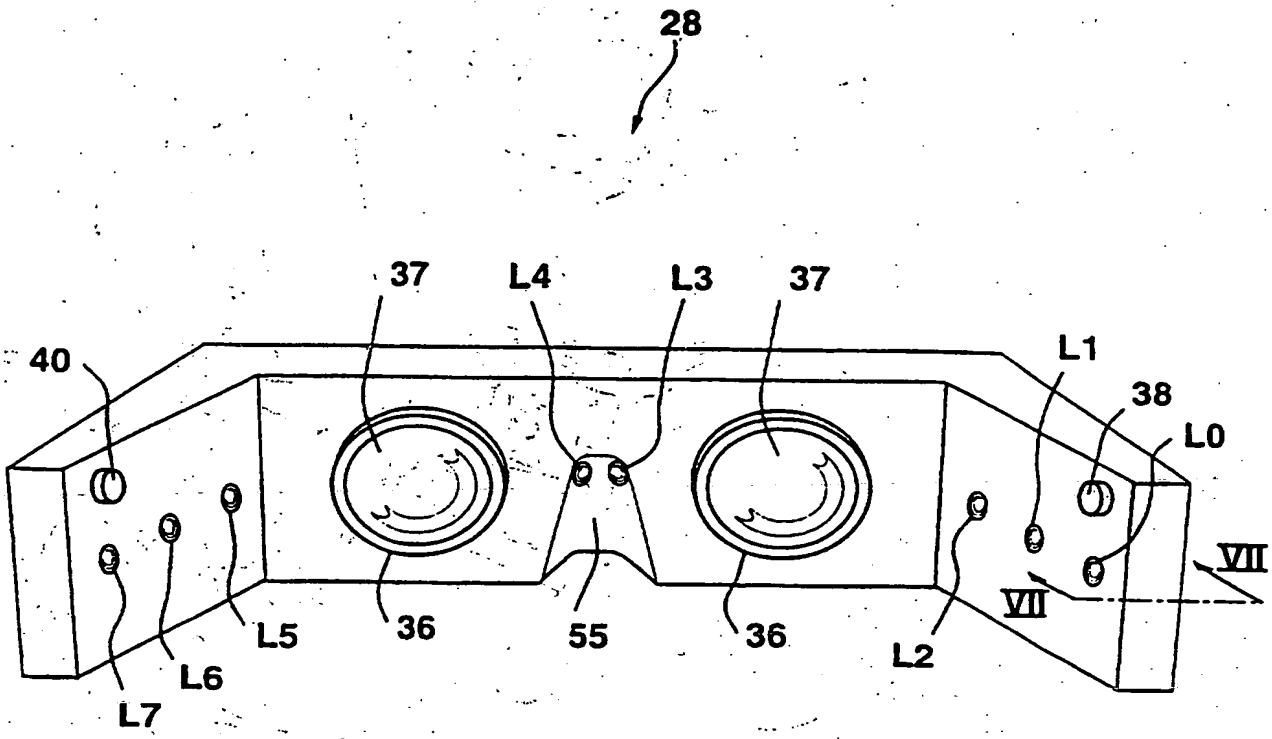

FIG. 6

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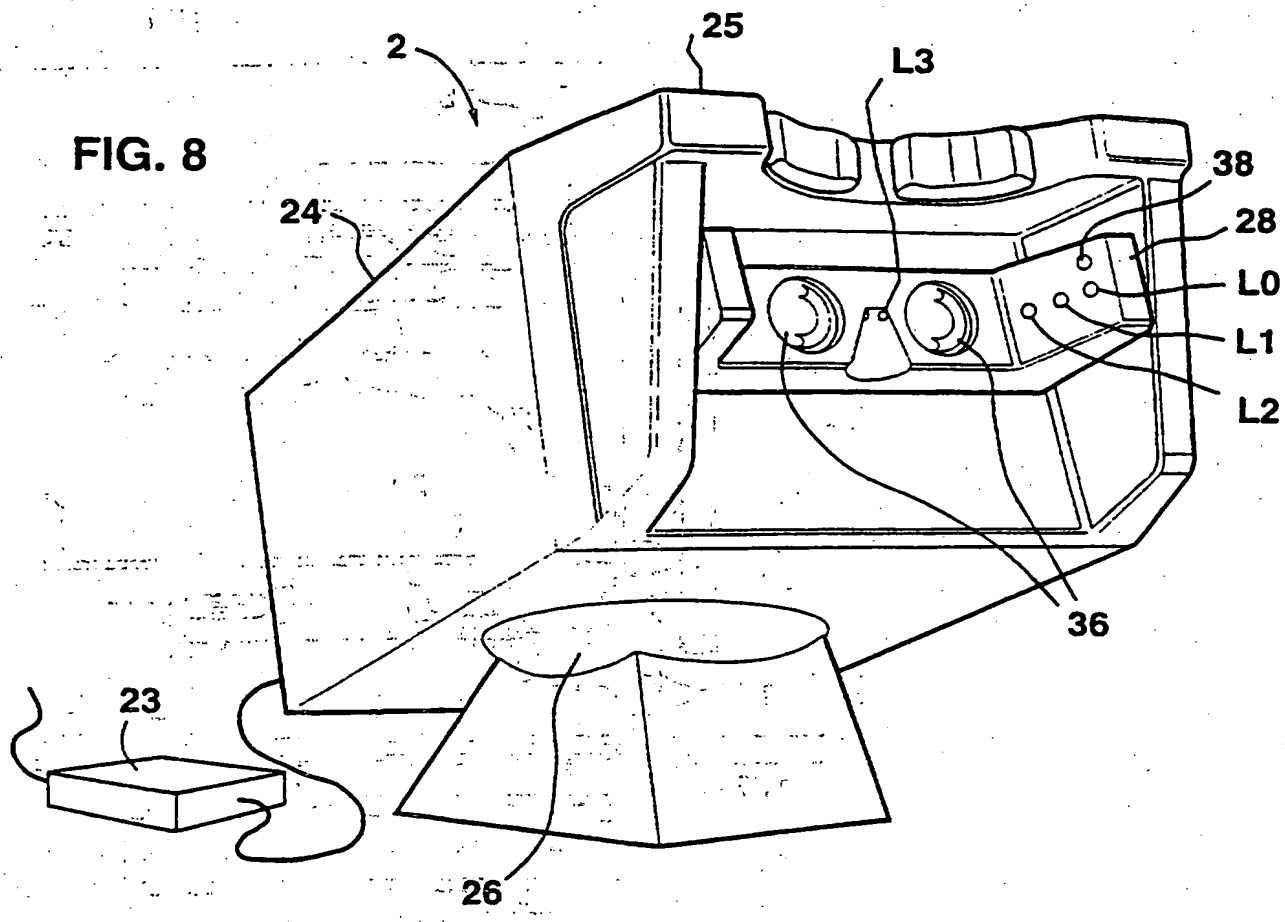
FIG. 8



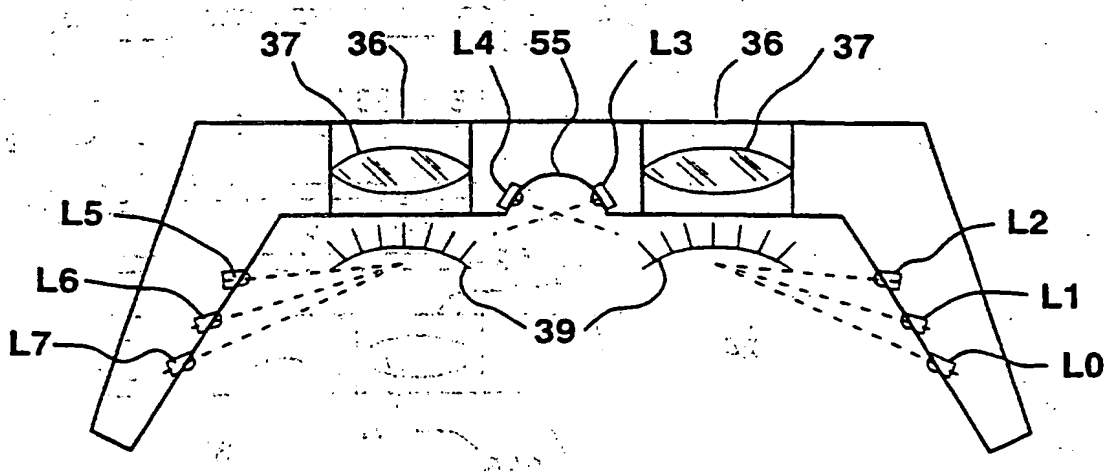


FIG. 7

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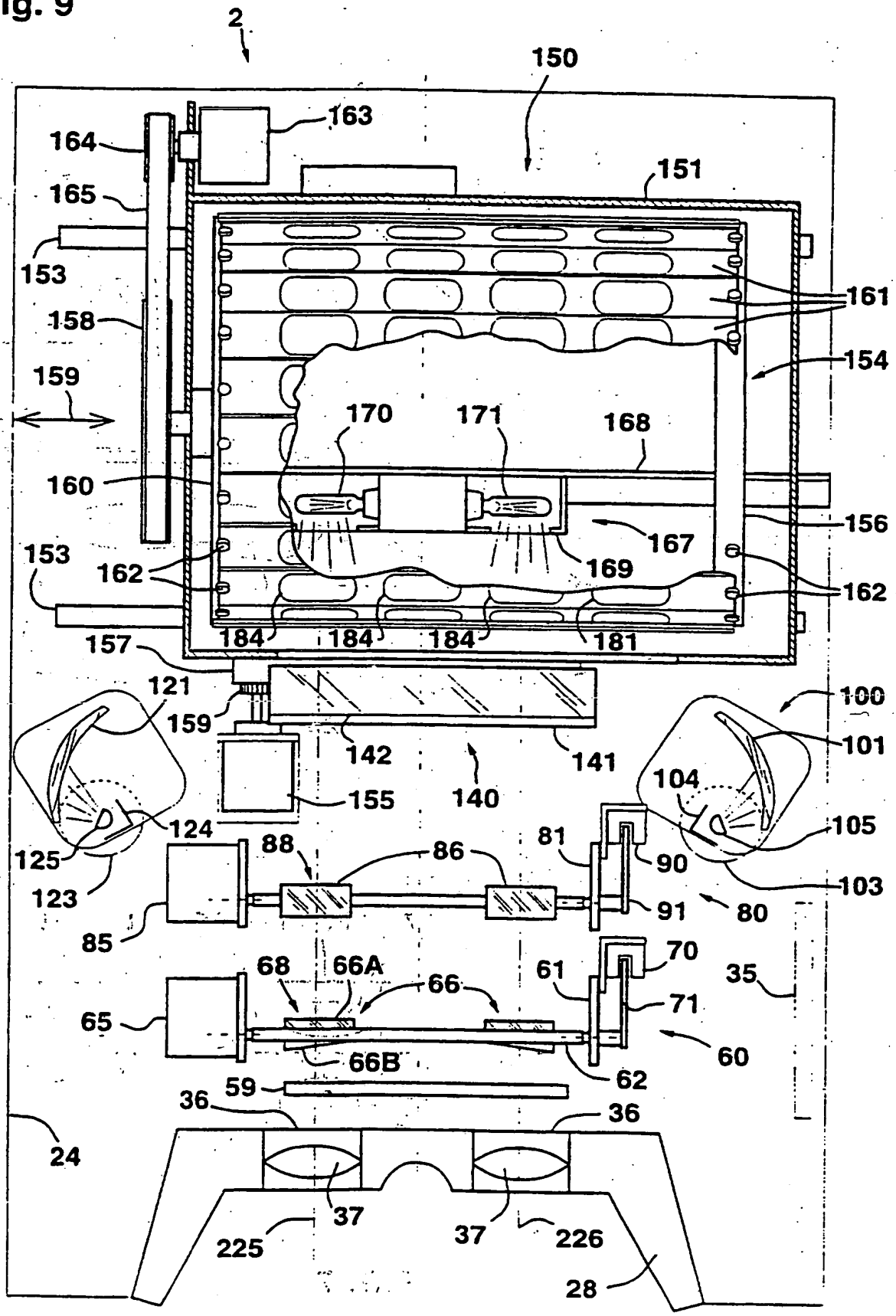
Fig. 9



SUBSTITUTE SHEET (RULE 26)

BNSDOCID: <WO 9802083A2 I >

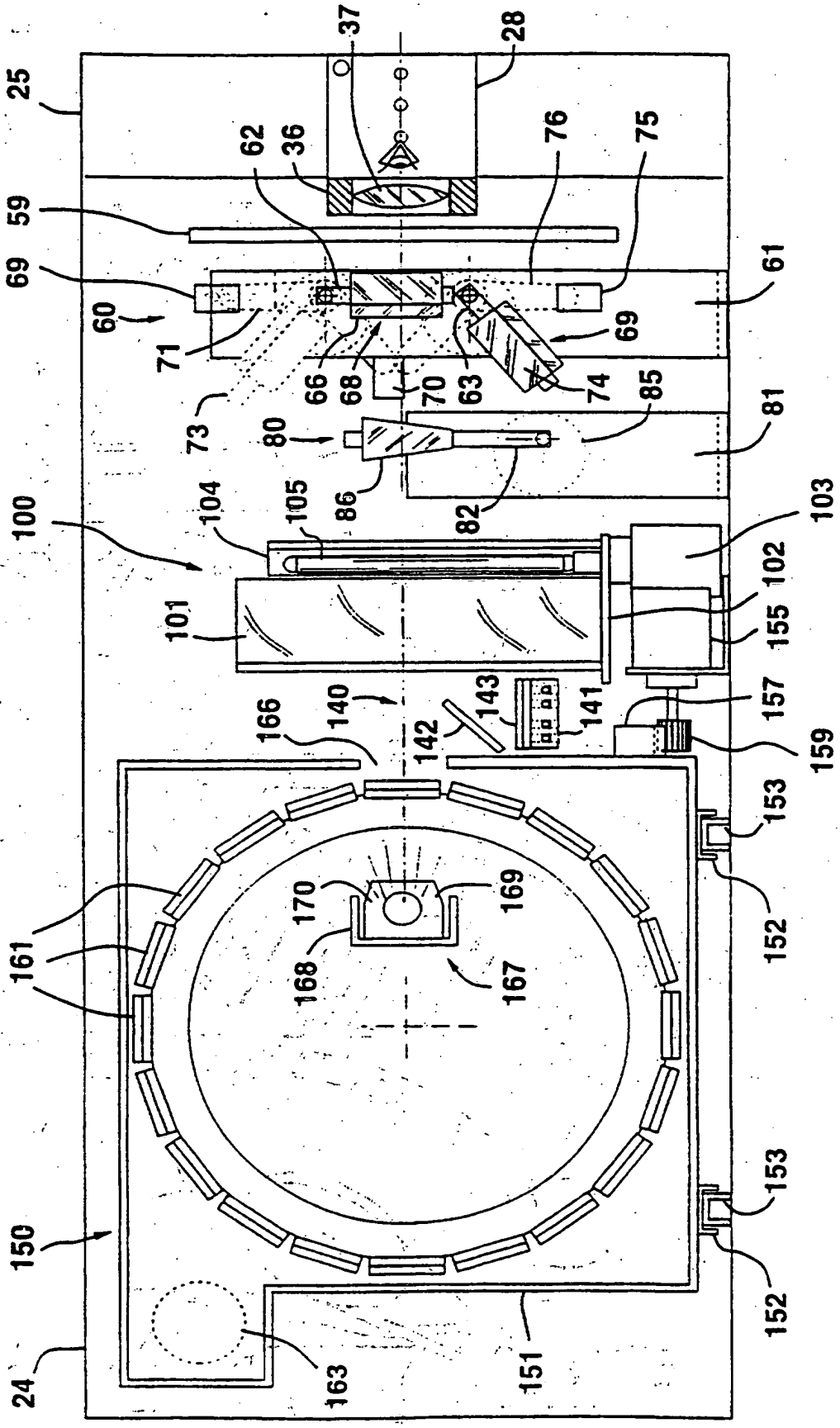
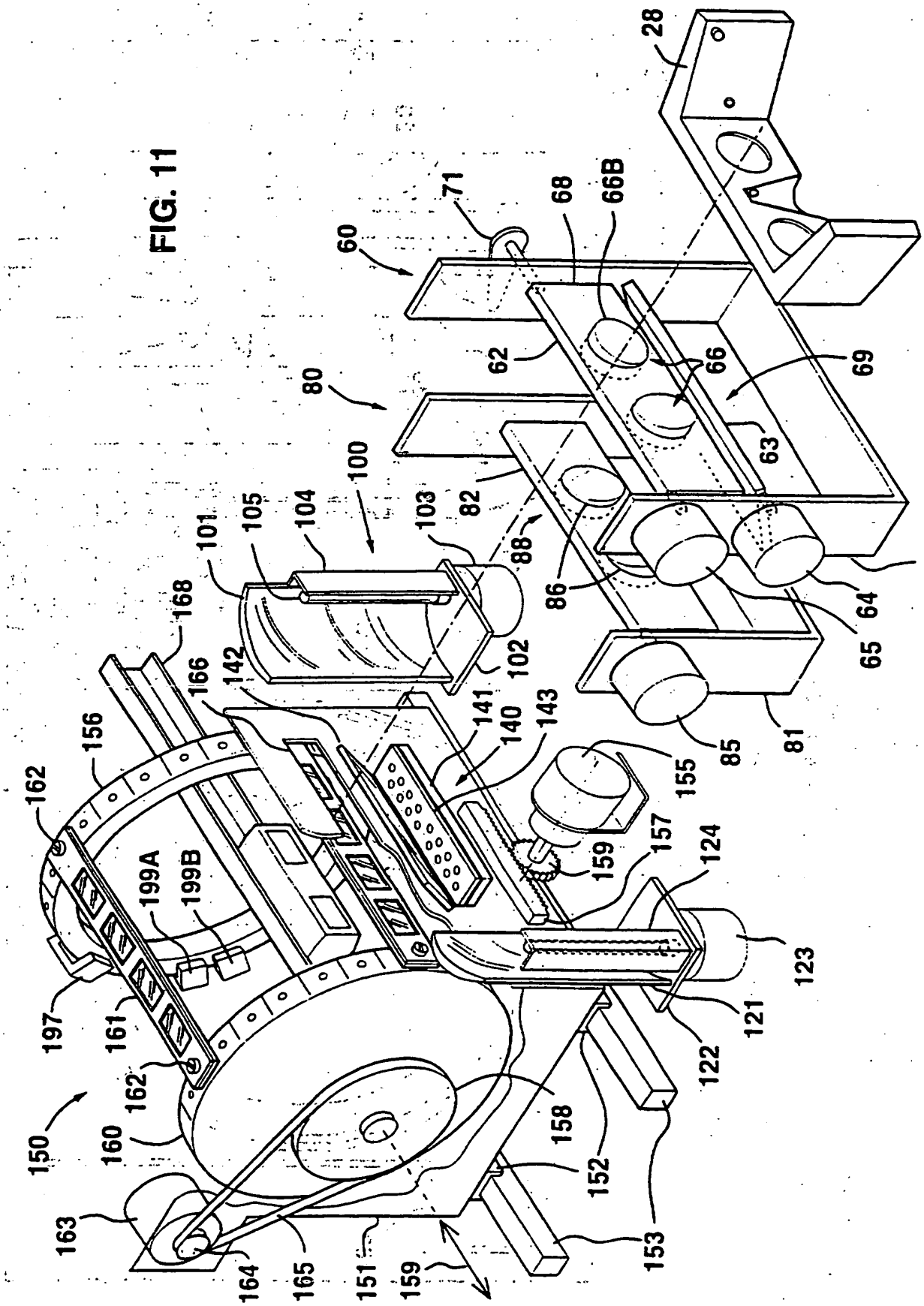


FIG. 10

BNSDOCID: <WO___9802083A2_I_>

FIG. 11



SUBSTITUTE SHEET (RULE 26)

BNSDOCID: <WO 9802083A2 I >

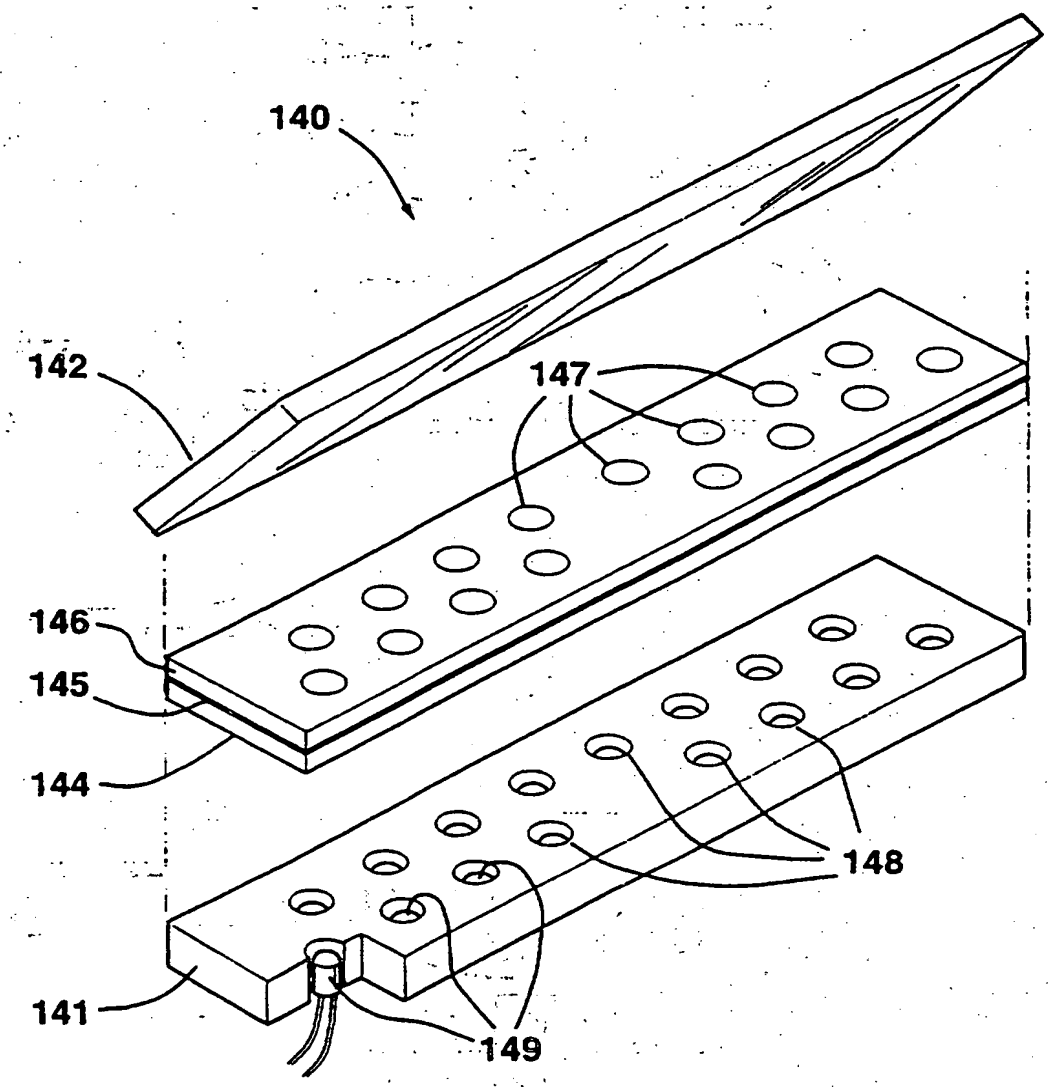
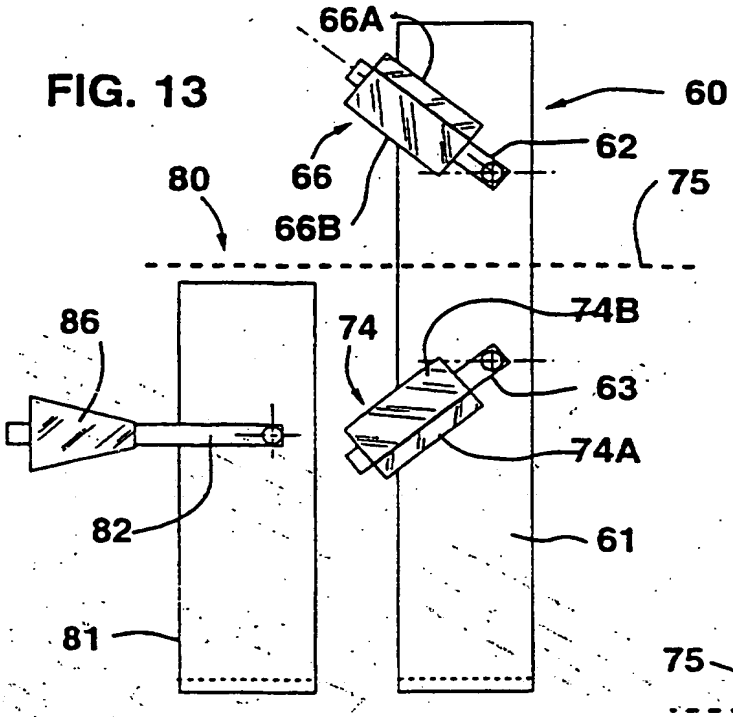


FIG. 12

BNSDOCID: <WO___9802083A2_I_>

FIG. 13



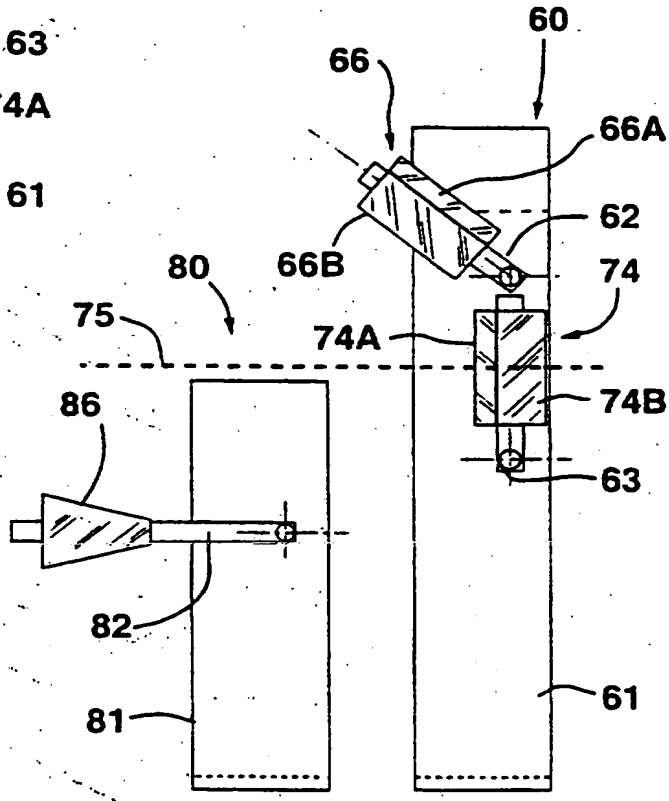
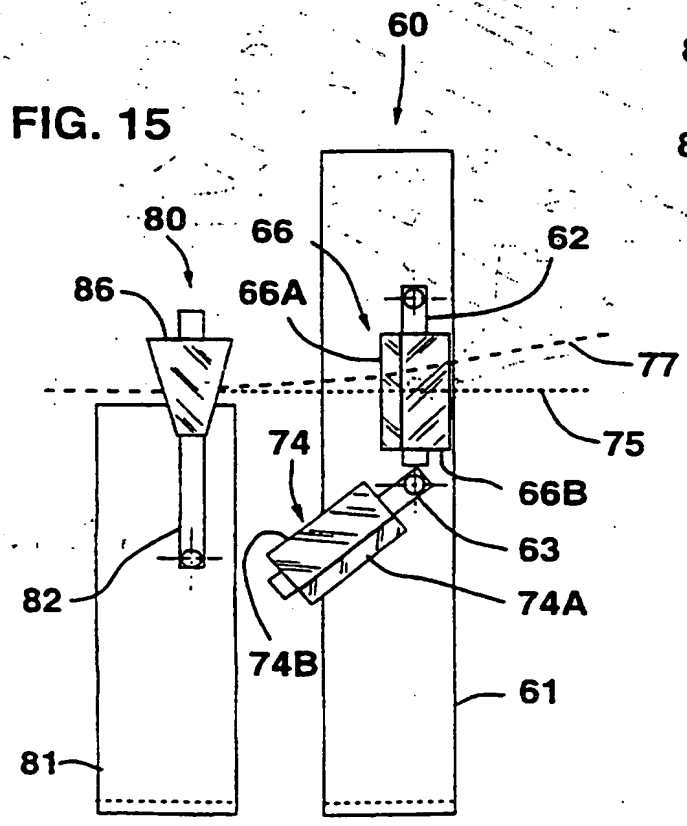


FIG. 14

FIG. 15



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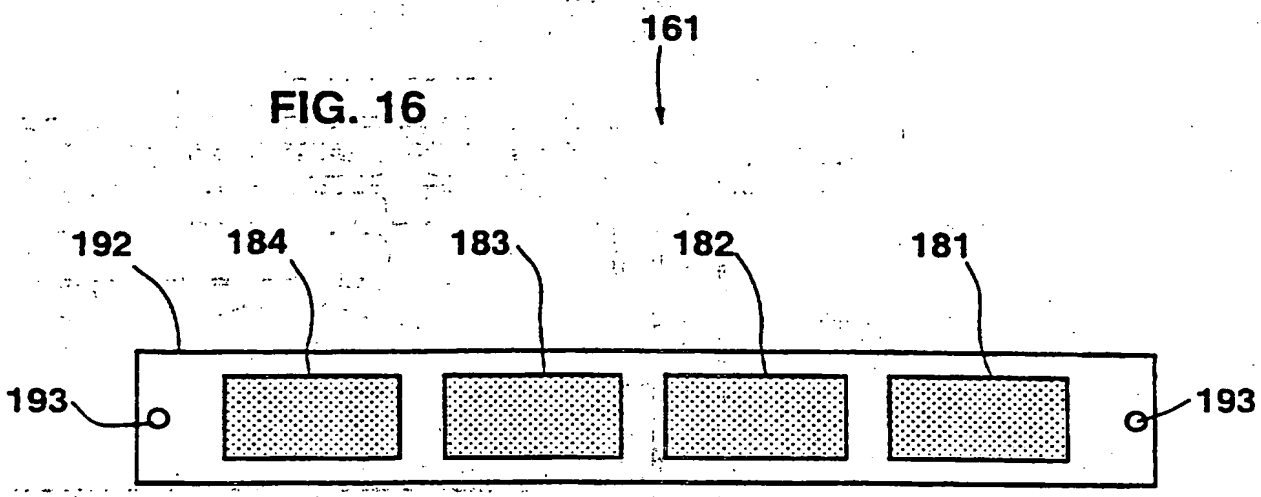


FIG. 16

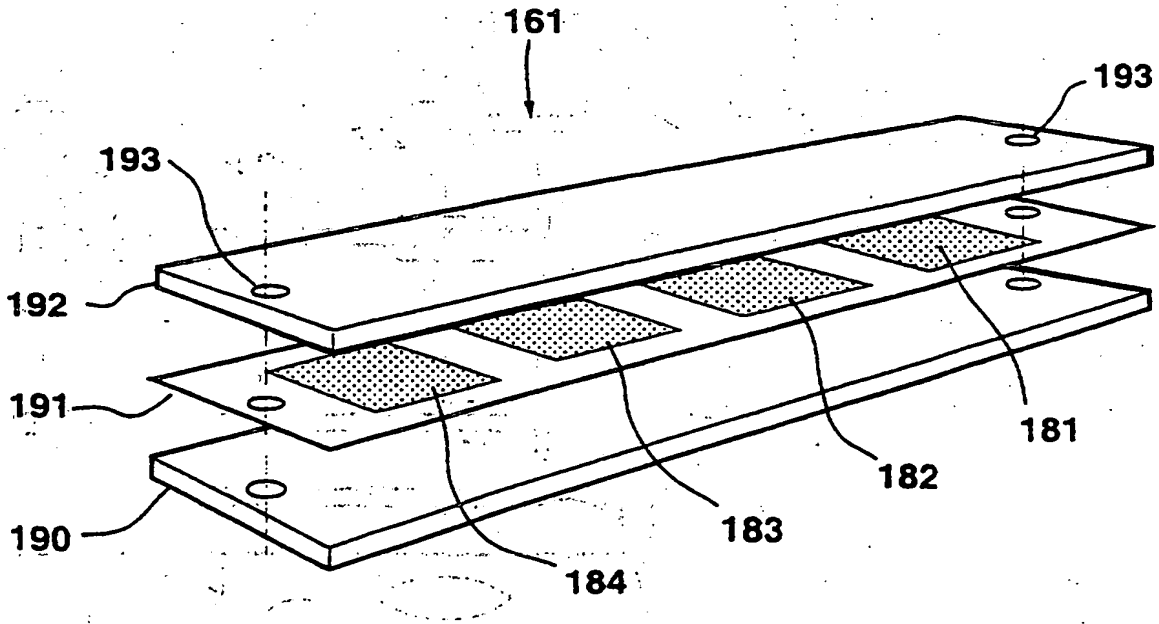
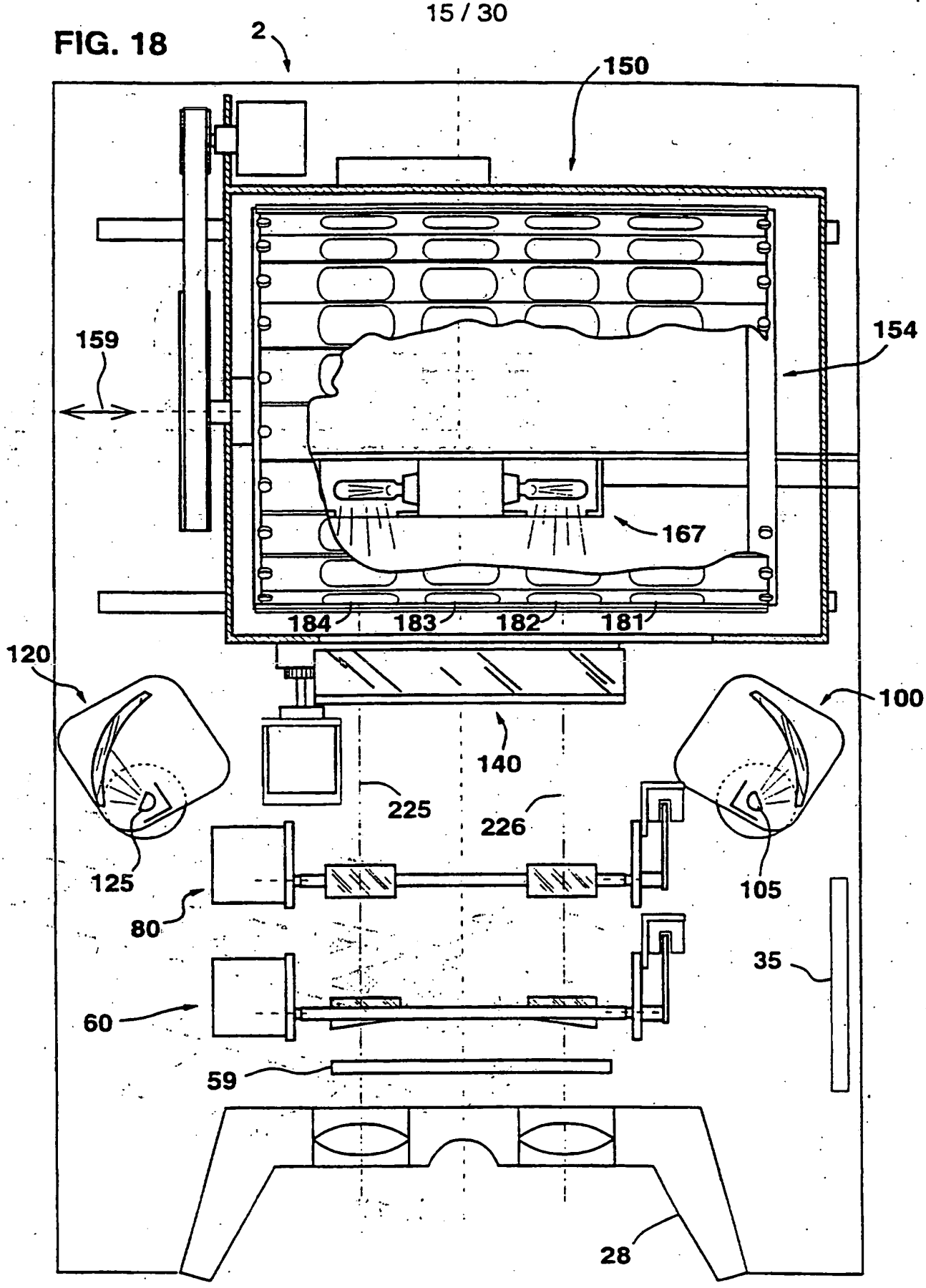


FIG. 17

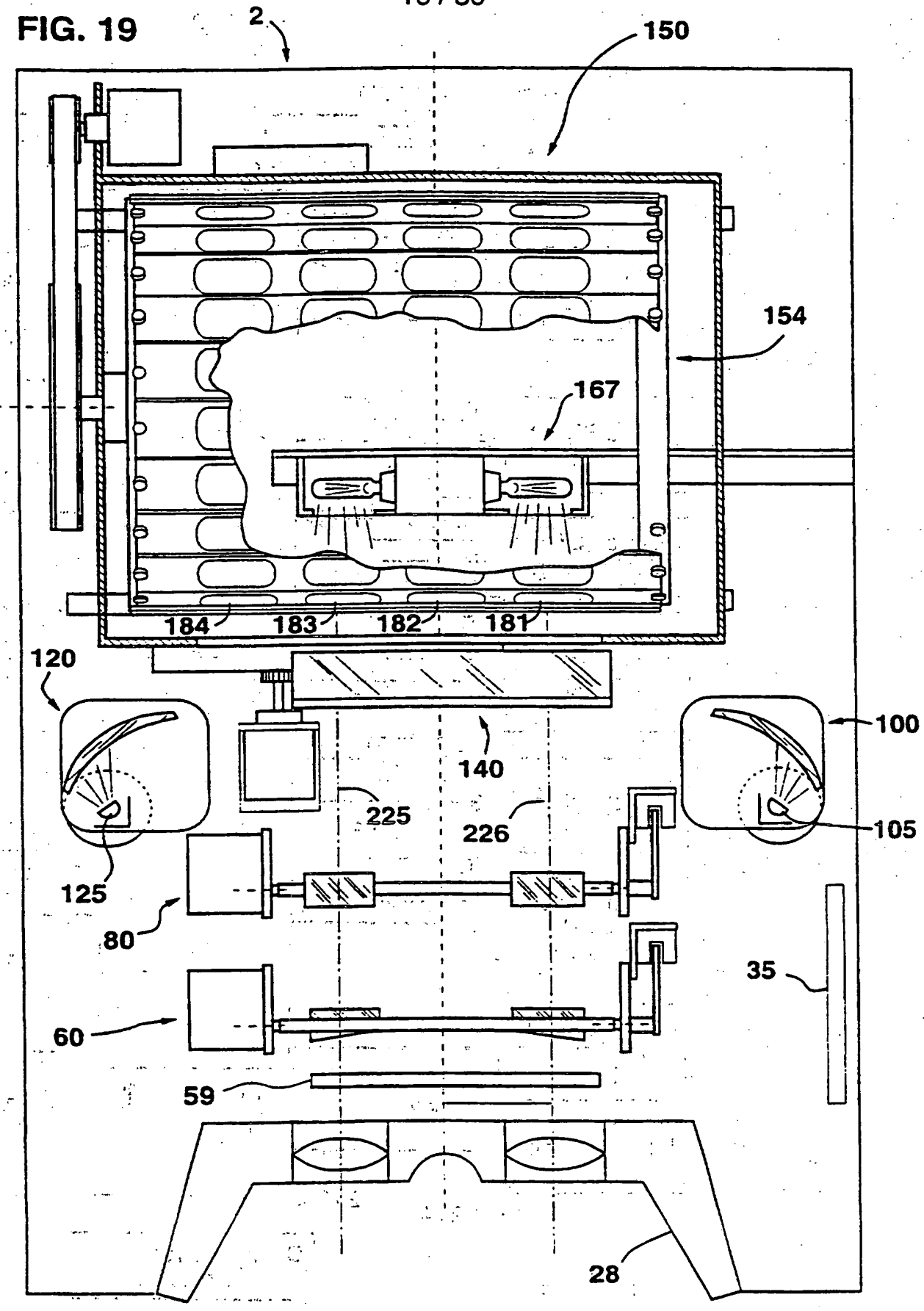
BNSDOCID: <WO___9802083A2_I_>

FIG. 18



BNSDOCID: <WO 9802083A2 I >

FIG. 19



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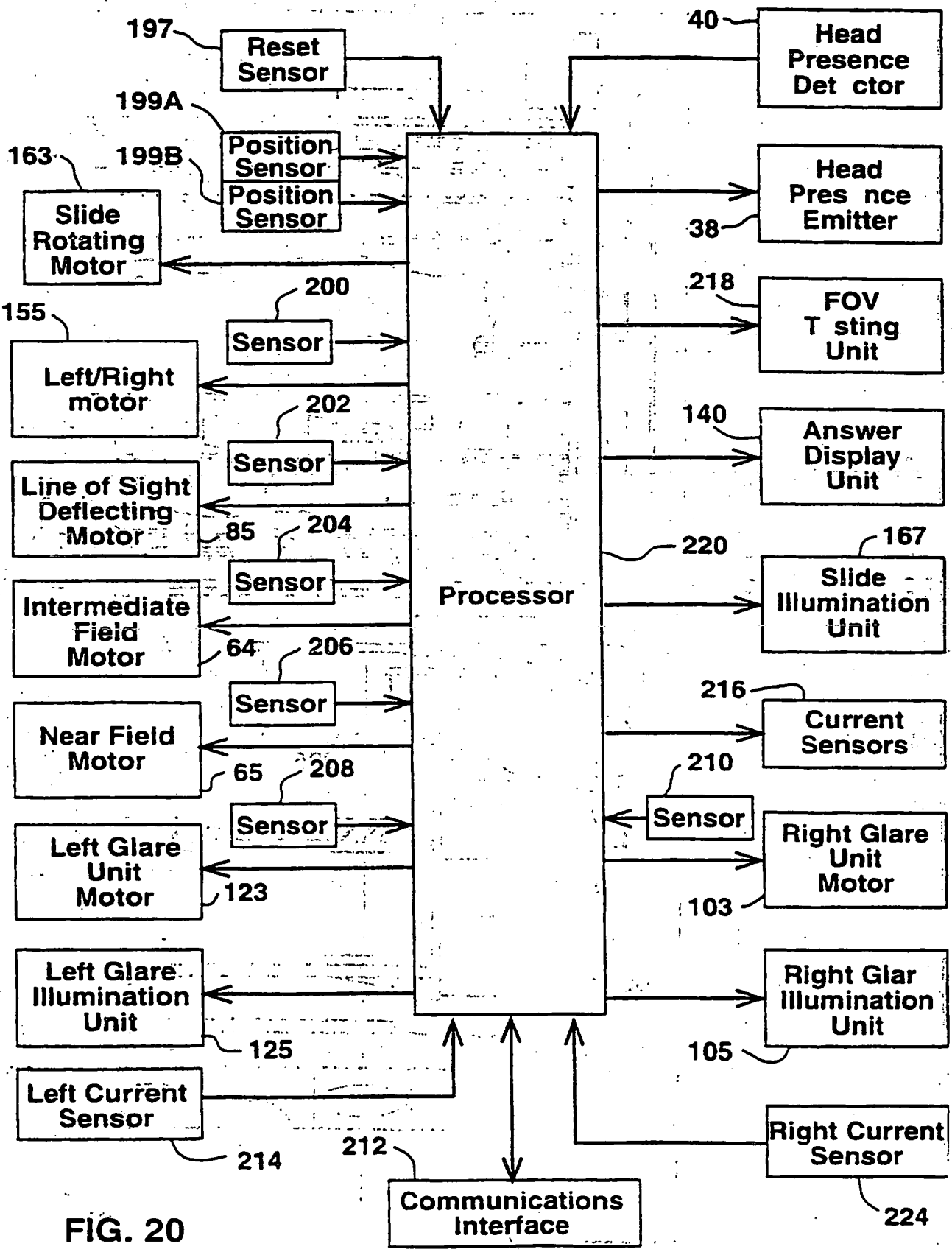

197
Reset Sensor
199A
Position Sensor
199B
Position Sensor
163
Slide Rotating Motor
155
Left/Right motor
200
Sensor
202
Sensor
Line of Sight Deflecting Motor
85
204
Sensor
Intermediate Field Motor
64
206
Sensor
Near Field Motor
65
208
Sensor
Left Glare Unit Motor
123
Left Glare Illumination Unit
125
Left Current Sensor
214
212
Communications Interface
Processor
40
Head Presence Det ctor
Head Pres nce Emitter
38
218
FOV T sting Unit
140
Answer Display Unit
220
167
Slide Illumination Unit
216
Current Sensors
210
Sensor
Right Glare Unit Motor
103
Right Glar Illumination Unit
105
Right Current Sensor
224

FIG. 20

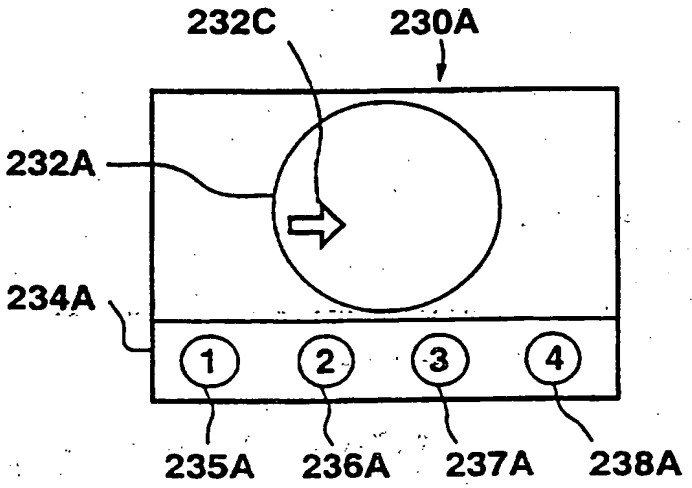


FIG. 21A

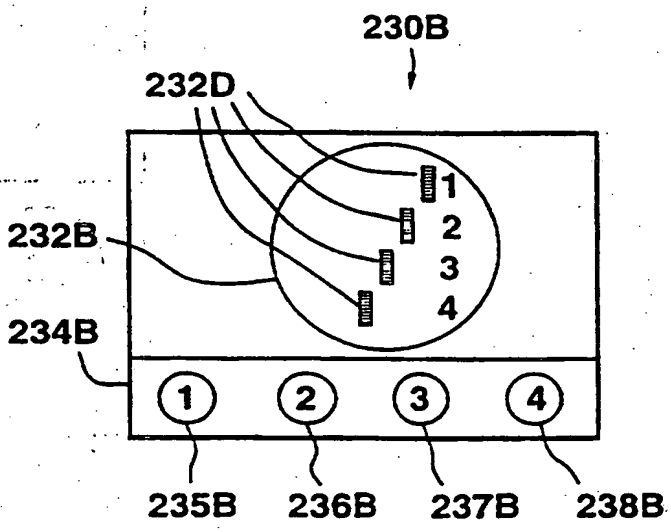


FIG. 21B

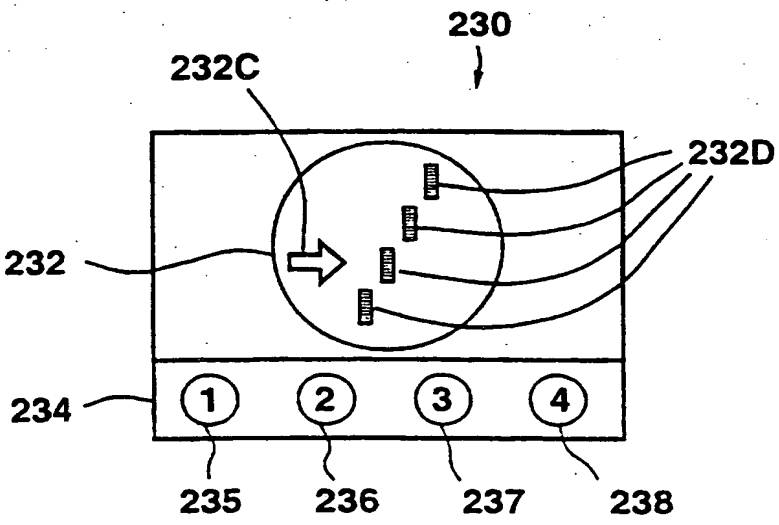


FIG. 21C

BNSDOCID: <WO___9802083A2_1_>

FIG. 22

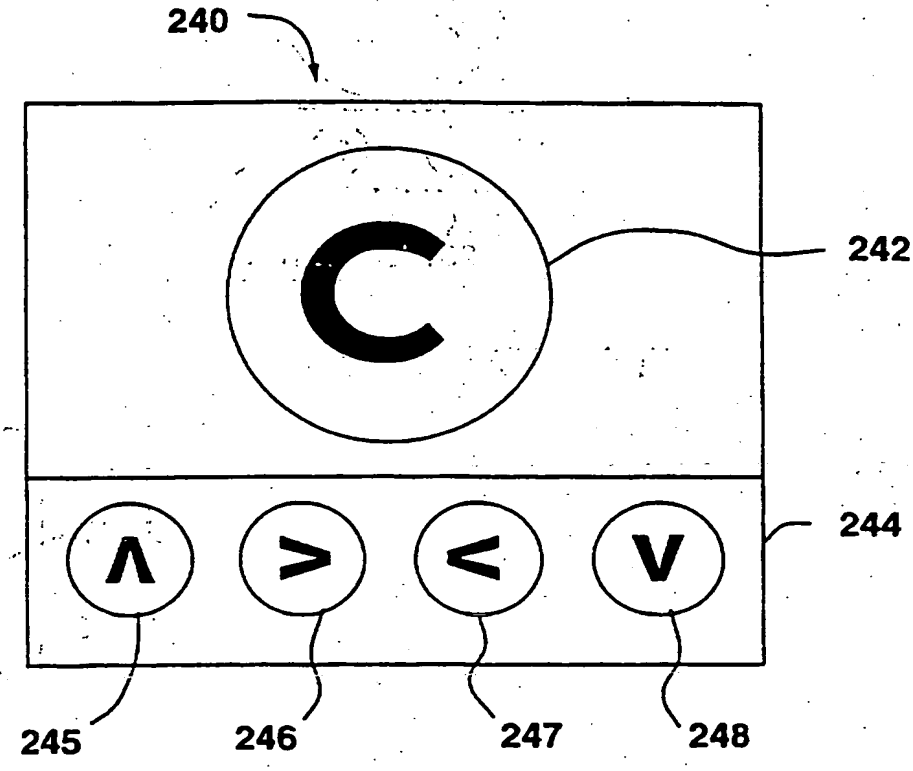
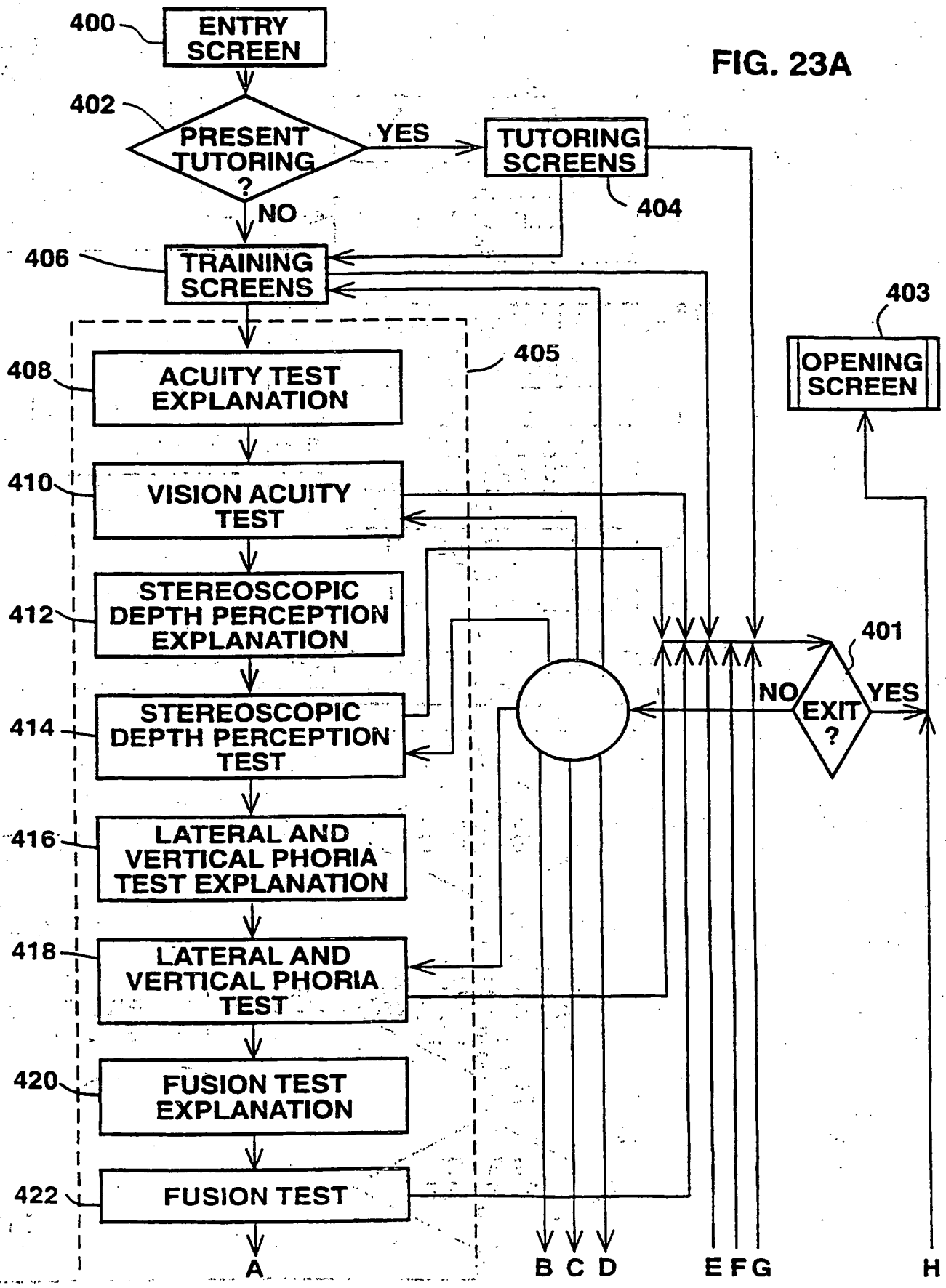


FIG. 23A



BNSDOCID: <WO___9802083A2_I_>

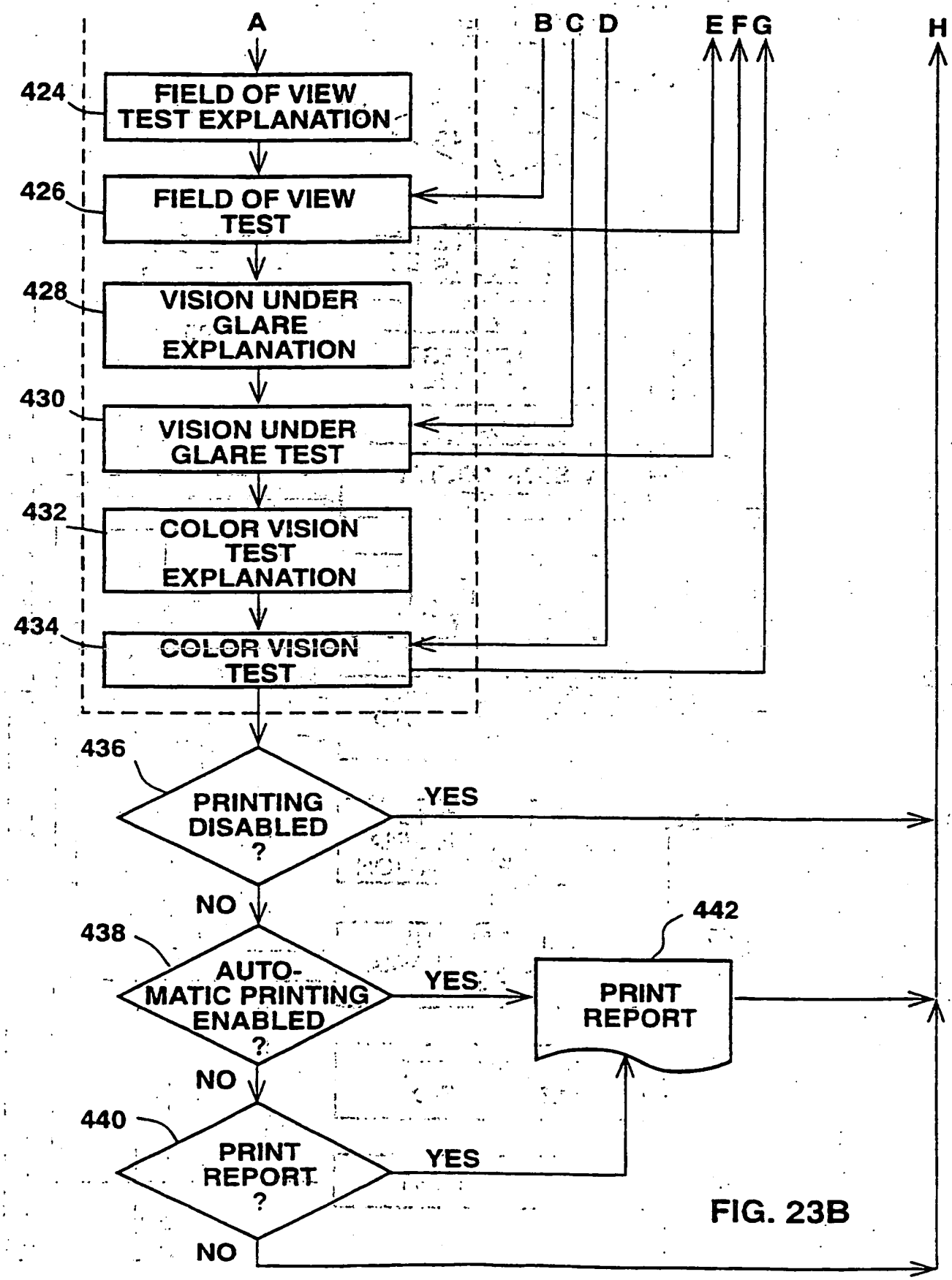
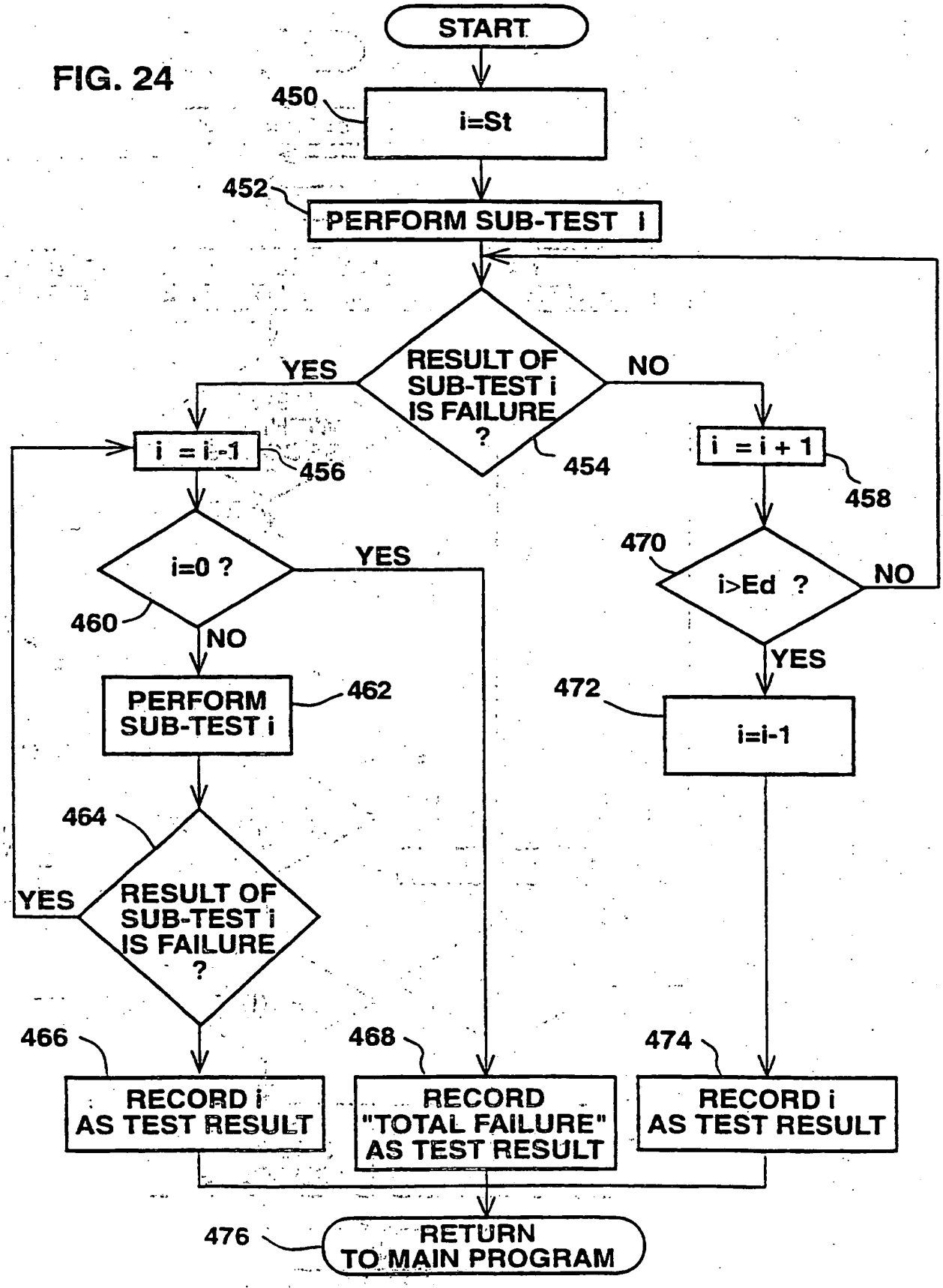


FIG. 23B

BNSDOCID: <WO___9802083A2_I_>

FIG. 24



BNSDOCID: <WO___9802083A2_I_>

FIG. 25

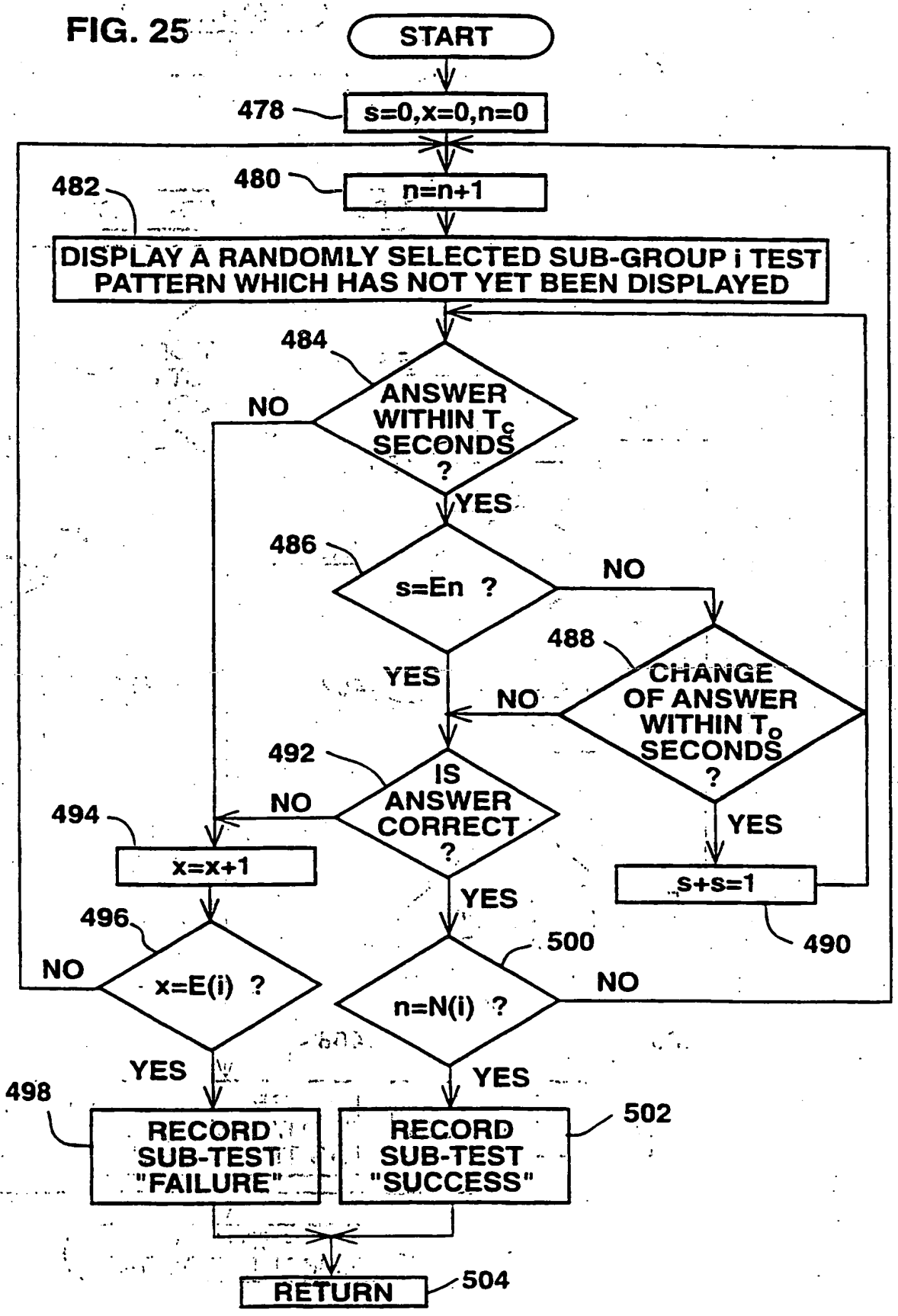
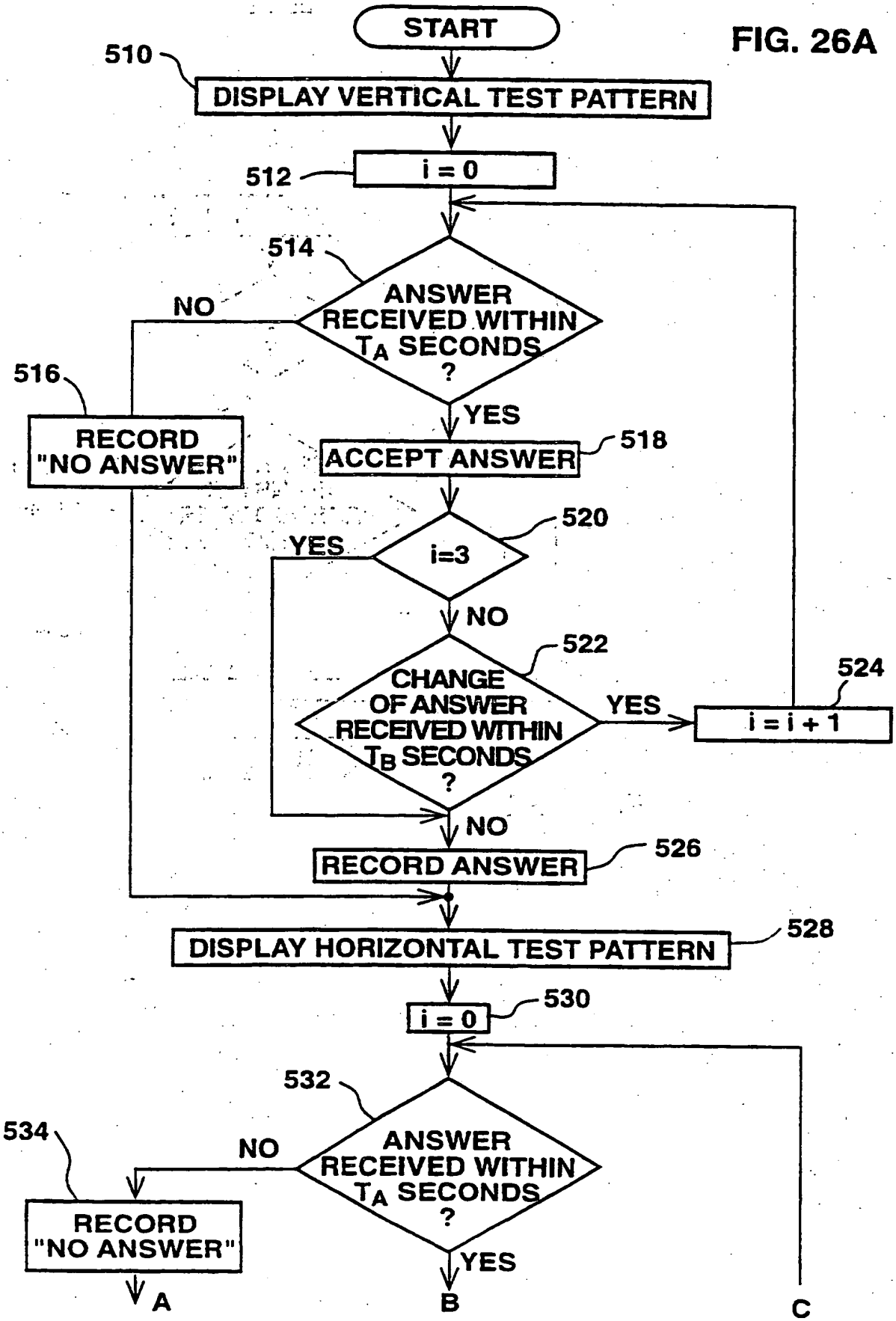

START
478
s=0,x=0,n=0
480
n=n+1
482
DISPLAY A RANDOMLY SELECTED SUB-GROUP i TEST PATTERN WHICH HAS NOT YET BEEN DISPLAYED
484
ANSWER WITHIN T_c SECONDS ?
NO
YES
486
s=En ?
NO
YES
488
CHANGE OF ANSWER WITHIN T_o SECONDS ?
NO
YES
492
IS ANSWER CORRECT ?
NO
YES
494
x=x+1
s+s=1
490
496
x=E(i) ?
NO
YES
500
n=N(i) ?
NO
YES
498
RECORD SUB-TEST "FAILURE"
502
RECORD SUB-TEST "SUCCESS"
RETURN
504

FIG. 26A



BNSDOCID: <WO___9802083A2_I_>

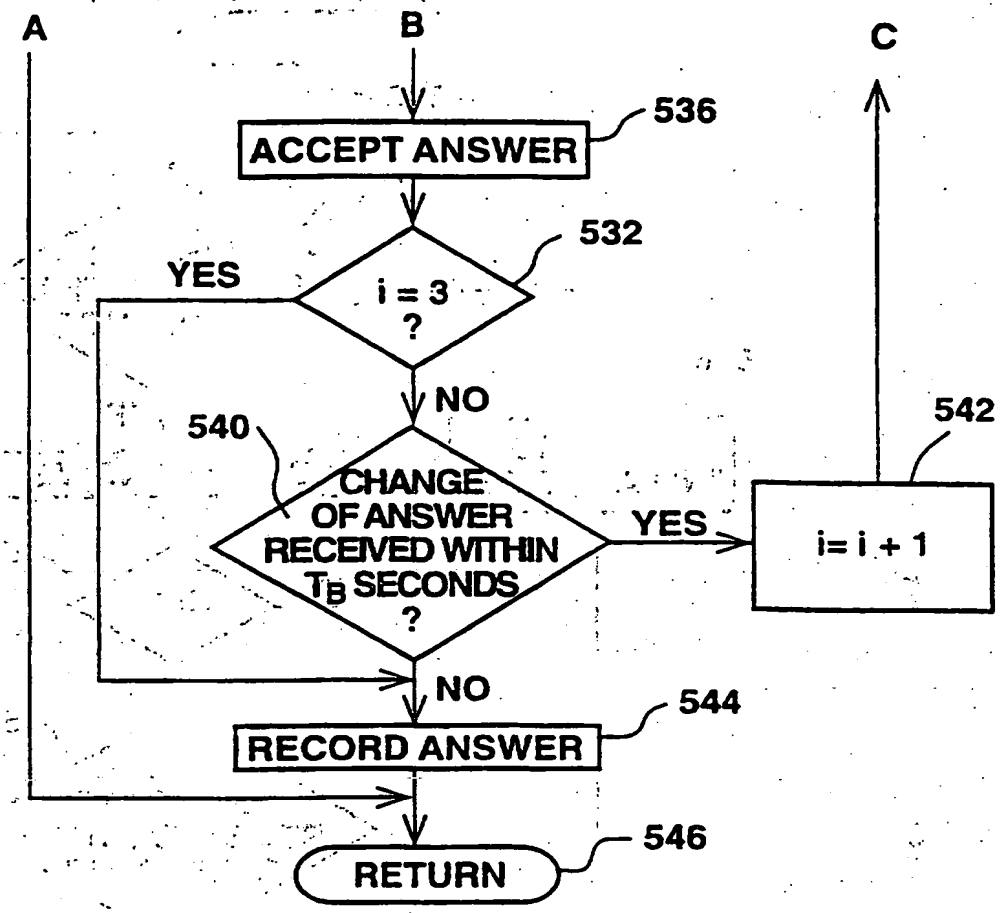
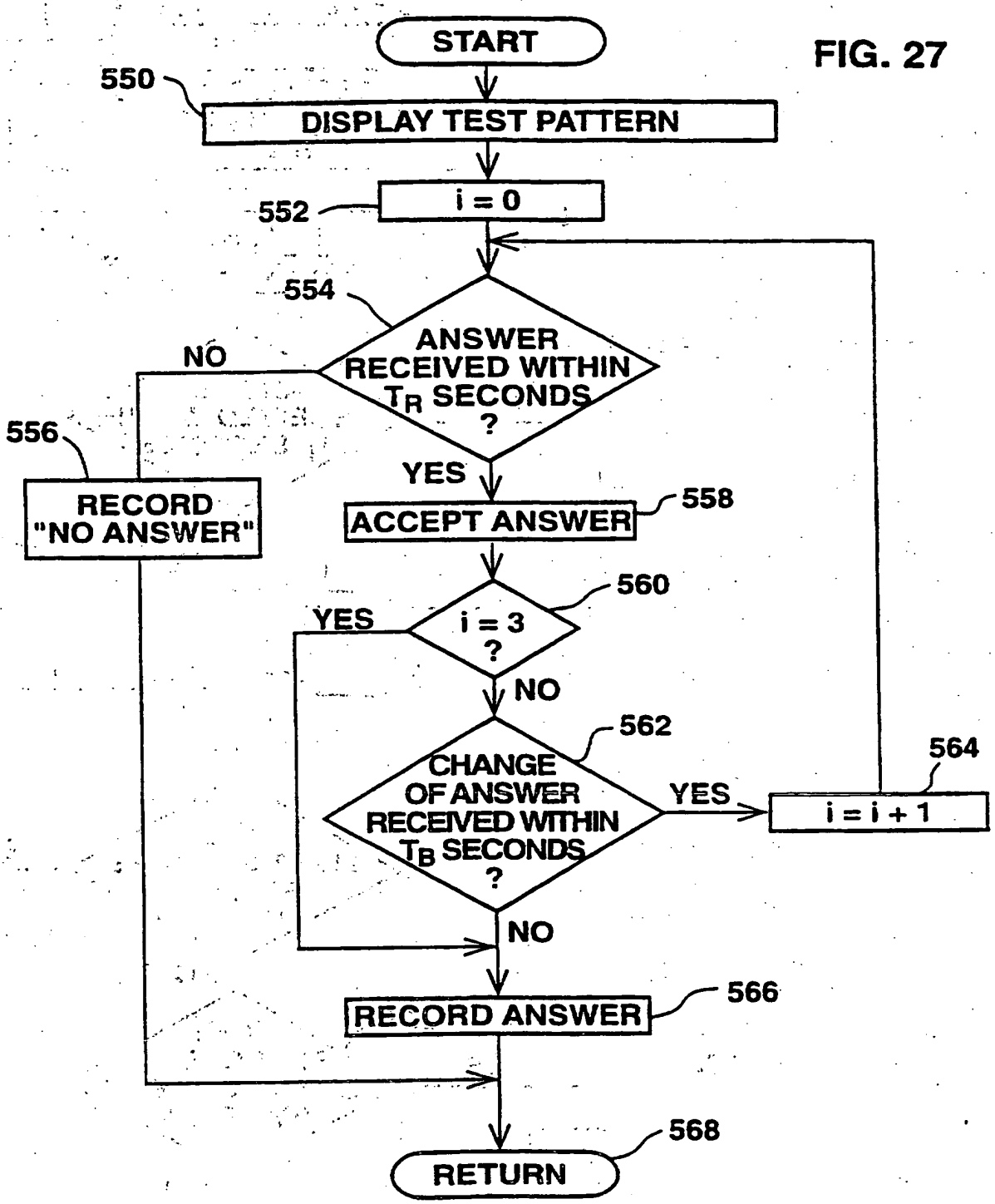

A
B
C
ACCEPT ANSWER
536
532
YES
i = 3 ?
NO
540
542
CHANGE OF ANSWER RECEIVED WITHIN T_B SECONDS ?
YES
i= i + 1
NO
544
RECORD ANSWER
546
RETURN

FIG. 26B

FIG. 27



BNSDOCID: <WO___9802083A2_I_>

FIG. 28

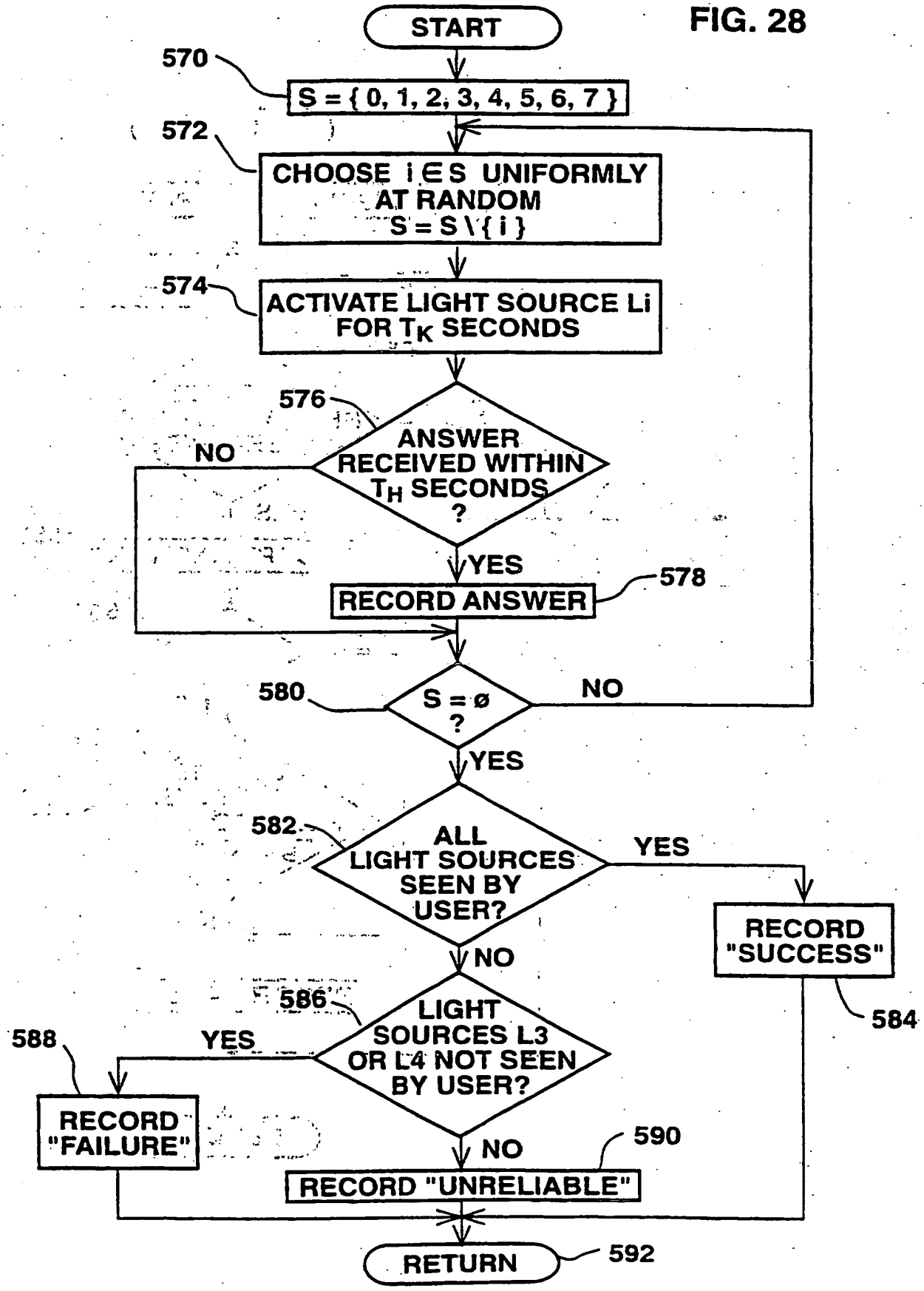
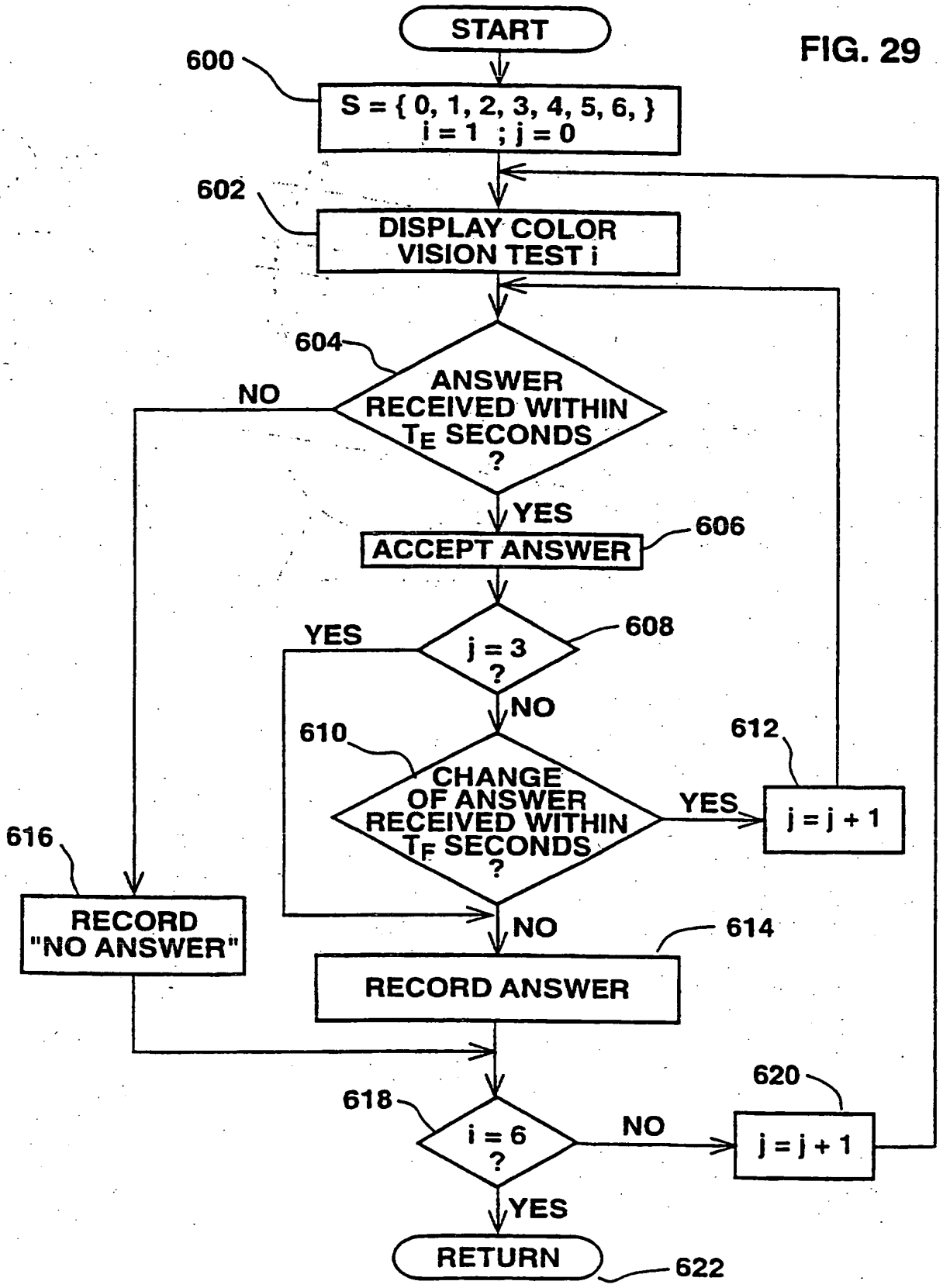

START
570
S = { 0, 1, 2, 3, 4, 5, 6, 7 }
572
CHOOSE i ∈ S UNIFORMLY AT RANDOM
S = S \ { i }
574
ACTIVATE LIGHT SOURCE Li FOR T_K SECONDS
576
ANSWER RECEIVED WITHIN T_H SECONDS ?
NO
YES
578
RECORD ANSWER
580
S = ø ?
NO
YES
582
ALL LIGHT SOURCES SEEN BY USER?
YES
RECORD "SUCCESS"
584
NO
586
LIGHT SOURCES L3 OR L4 NOT SEEN BY USER?
588
YES
RECORD "FAILURE"
NO
590
RECORD "UNRELIABLE"
RETURN
592

FIG. 29



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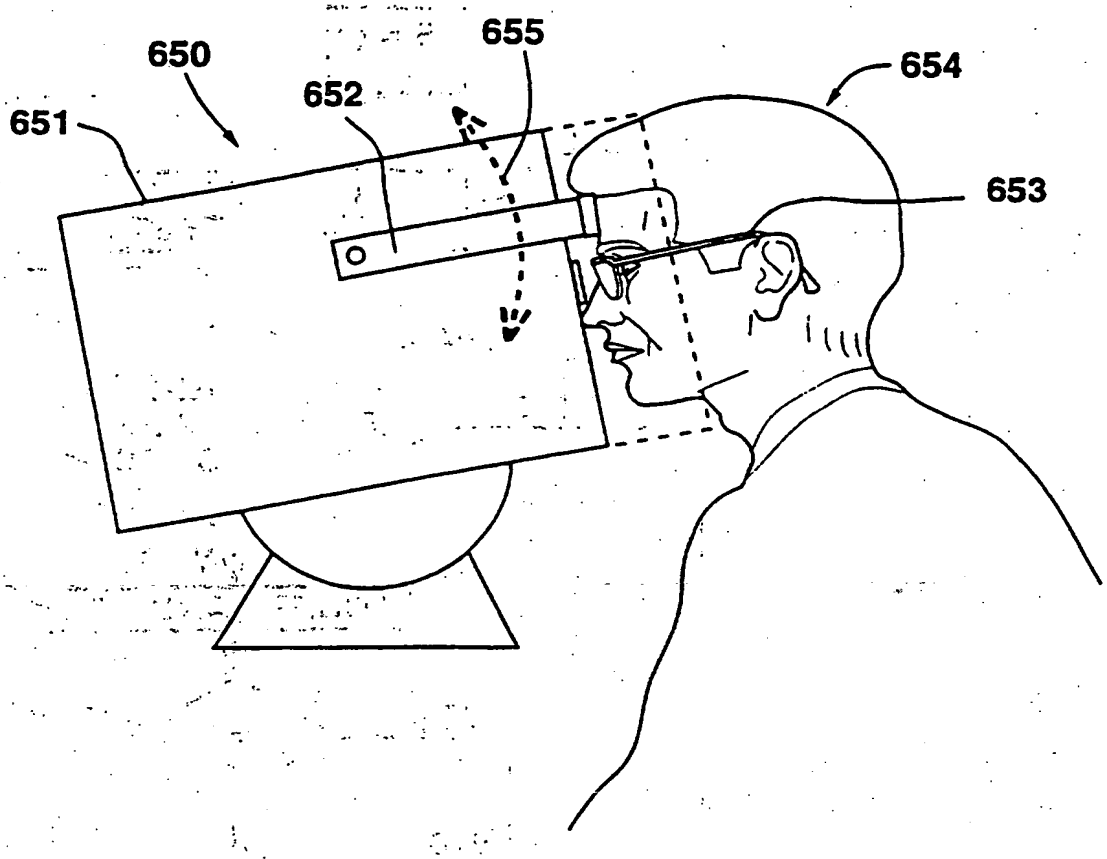
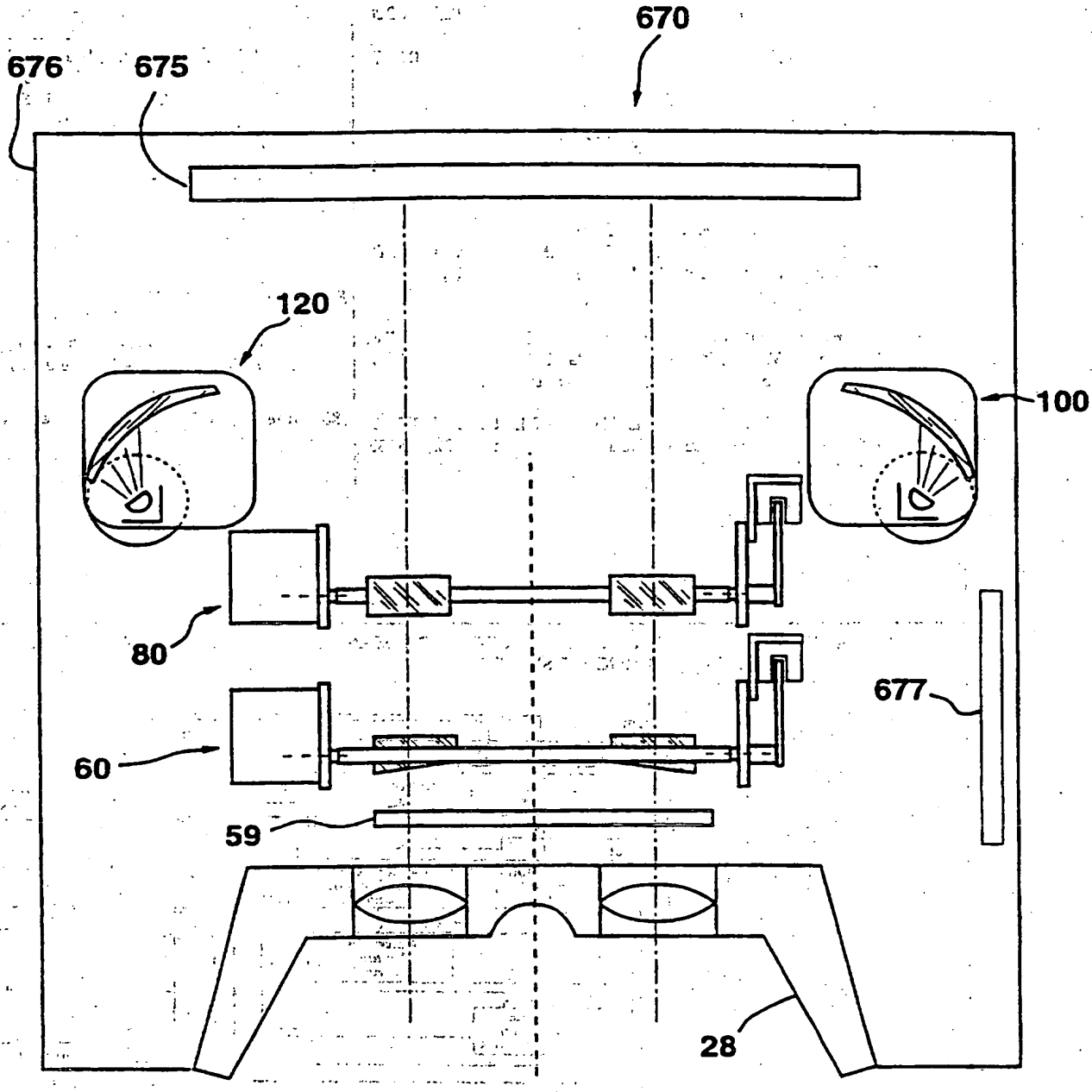


FIG. 30

FIG. 31



BNSDOCID: <WO___9802083A2_I_>